Unit 17 Denmore Industrial Estate, Denmore Road, Bridge of Don, Aberdeen AB23 8JW

User Manual
3’’ Modular BOP System

OPS-4611

This is a certified safety critical product and modifications or changes not authorised by Phuel Oil Tools may compromise the Safety, Functionality and Certification of the assembly.

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Revision History

Issue, Release Date	Description
Rev A, 02 Feb 12	Initial Issue
Rev B, 08 May 12	Addition of Height of Modular Body to aid Calculation of Make-Up Length/Height
Rev C, 07 Jan 13	Correction to Shear Ram Part numbers, 5 Yr Maintenance text change to ref E101.
Rev D, 16 Sep 13	Simplified yearly inspection (6.2.2) and improved test procedure (7.1)

Safety

WARNING: Trapped air requires considerable time to compress and when it is compressed is highly dangerous. It has enough stored energy to separate parts with considerable force.

This product contains high pressures, when in operation. Failure of any part may cause injury. Welding, corrosion, rough handling, or other abuse may affect the Integrity of this product.

All pressure equipment has a particular pressure rating and care must be taken to ensure that no item is used in a situation that may cause its working pressure to be exceeded.

All personnel involved in pressure testing must be formally trained, competent and utilise the appropriate PPE.

Ensure the identification plate is fitted and is displaying the correct information

This equipment and the equipment it is attached to is heavy never position yourself below a suspended load

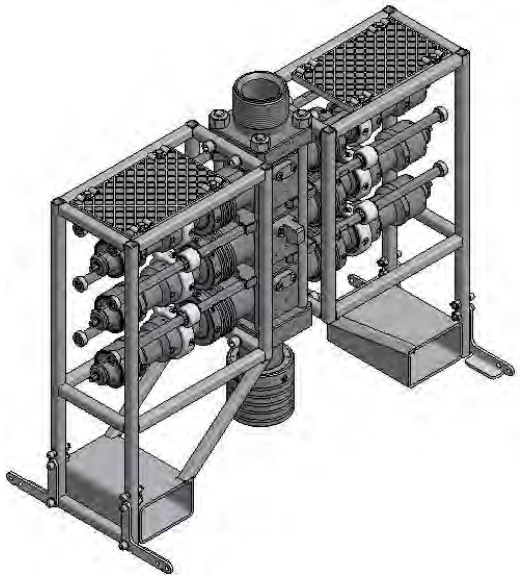


Figure 1: 3’’ Modular BOP (Triple Build)

1 Introduction

1.1 General

The Modular Blow Out Preventer (BOP) provides essential safety barriers against well pressure during wireline operations. It is usually located directly above the Xmas tree flange. The BOP (Depending on configuration) can have one or more sets of wireline rams for sealing against well pressure on slick line and/or braided line. Shear and seal rams are also available these are capable of cutting through the wire and then sealing against the well pressure.

The modular concept allows the operator to configure the BOP as required to suit even special operations utilising single or multiple modules in varying configurations. The main advantage comes when maintaining the equipment as ram bodies can be easily changed out with spares more cost effectively allowing the asset use to be maximised.

The ram consists of a manual or hydraulic piston that can be extended or retracted to energise or retract the ram. The ram has a set of inner and horse shoe outer seals that when compressed against the opposite ram forms a continuous seal that is further energised by the application of pressure in one direction. The ram consequently can be arranged so that it holds pressure from below the BOP or from above.

Across the rams there is an equalisation valve assembly. This is used to equalise pressure across the rams so that the rams can be withdrawn to open up the well bore. The equalisation valve assembly consists of a cone seal set on a screw. Unwinding the screw opens the valve and allows equalisation across the rams. Tightening the screw closes the seal and prevents pressure from passing through the valve assembly. There is also a circuit to allow the injection of chemicals into the well or across the equalisation valves, and can be used to prevent the valves freezing while bleeding down gas (by injecting glycol for example). The injection port has a check valve to prevent well pressure entering the injection system.

The BOP can be mounted to a crash frame assembly that provides forklift pockets protection during transport.

This user manual serves as an introduction to the equipment and contains the relevant specifications, operation, planning and maintenance instructions, parts list and drawings.

1.2 Product Identification

Phuel products are identified by a unique serial number that facilitates full product traceability. Each product is supplied with a documentation pack that contains product certification and material/inspection reports. The serial number is always etched on the surface of the product but can sometimes be difficult to find or read after painting. A customer identification number is also included to allow the customer to track the asset in their system.

The nameplate tag that is stamped with the information shown below is secured either by a stainless steel band or fixed directly onto the assembly. This tag should be located in the first instance to ensure that this manual and any other paperwork refers to the correct equipment.

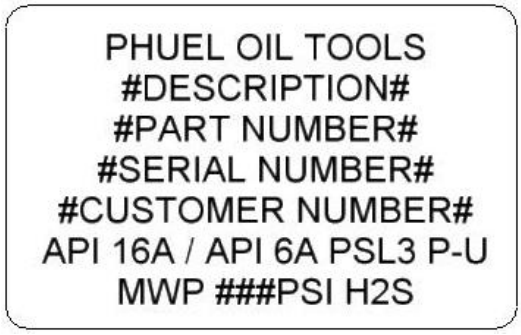


Figure 2: Typical identification tag

1.3 Modular Traceability Map

The modular BOP consists of individually certified assembles that are used to form an overall BOP. The standard configuration is a triple BOP but the modular design allows the BOP to be reconfigured to a single or dual BOP by removal of one or more of the individual assemblies or for individual modules to be replaced due to wear or damage. It is essential that the documentation is maintained for each module in the assembly so that the traceability records reflect the modules that have been assembled.

The modular traceability map is intended to assist the user in recording the important trace information and also ensuring that certified components remain with the relevant assemblies. The parts list section of this manual should be used to determine how assemblies and components are grouped together. It is recommended that the manufacturing documentation supplied with the BOP is reviewed before splitting the BOP to ensure that the assemblies can be put back together correctly with the traceability intact.

Record the numbers for each of the modules and ensure that it matches on the corresponding product certificate. The BOP will have been supplied with a map whan it was assembled in the factory and must be kept up to date whenever changes are made.

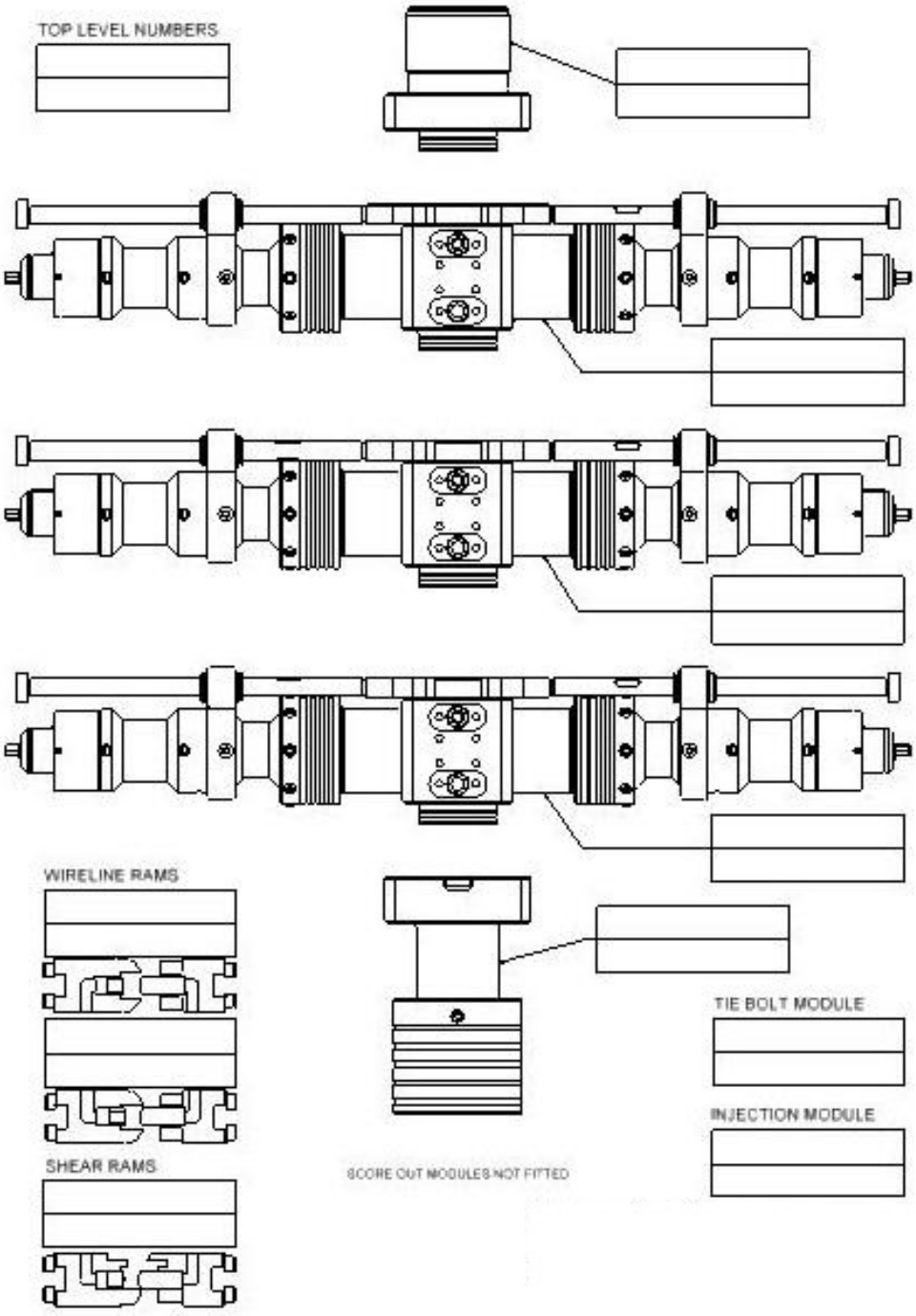


Figure 3: Generic 3'' Modular Map

2 Technical Specification

		Manual Actuator	Hydraulic Actuator
Working Pressure		10,000 Psi (May be further restricted by end connections fitted)	
Test Pressure		15,000 Psi (May be further restricted by end connections fitted)	
Service		H2S	
Hydraulic Pressure		N/A	2900 psi max (200 bar)
Stroke Volume		N/A	25 cu-in (0.41 Litre) Total Cycle 15.6 cu-in (0.26 Litre) to Close 9.4 cu-in (0.15 Litre) to Open
Weight	Single	331 lbs/ 155 kg	364 lbs/ 170 kg
	Dual	526 lbs/ 238.6 kg	592 lbs/ 268.5 kg
	Triple	721 lbs/ 327 kg	820 lbs/ 372 kg

Table 1: Technical Data

3 Technical Description

3.1 Basic Description

The Phuel BOP provides a positive barrier against well pressure while performing intervention operations. The equipment consists of one or more sets of rams, operated either manually or hydraulically, that can be individually closed to form a seal against pressure. The orientation of the ram outer seal determines whether the rams hold pressure from above or below. By opposing adjacent ram sets it is possible to apply pressure between the rams through a grease injection port, normally at a pressure greater than the well pressure, and thus form a positive protection barrier. This technique is particularly effective when sealing against braided wire-line as a leak tight seal cannot be obtained due to the construction of the wire. The high viscosity of the grease allows the pressure to be maintained even though a small leak (of grease) still exists.

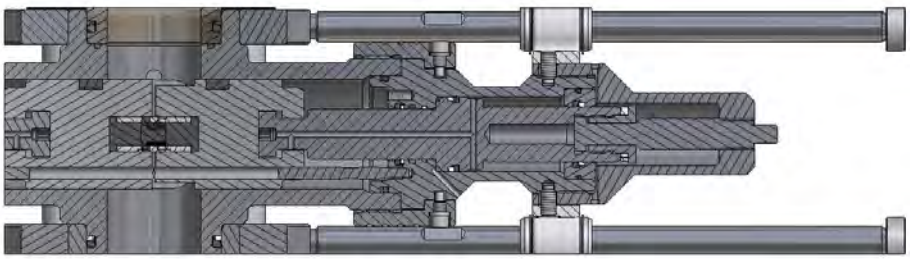


Figure 4: Section through BOP rams (closed position)

3.2 Balanced Piston

The actuator is designed with a balanced hydraulic piston that eliminates the end load that can be created due to well pressure. This means that the torque or closing pressure of the actuator is independent of the well pressure inside the BOP. This feature has two major advantages:

- The BOP can be closed with the same amount of effort no matter what the well bore pressure exists in the bore. This is particularly useful with a manual actuator and ensures quick and safe closure.
- The hydraulic volume requirements of the actuator are much less than a conventional BOP, this reduces the requirements for accumulator storage and charging.

4 Basic Operation

4.1 Operating the Rams

Note – Always ensure that the pressure across the rams has been equalised before opening.

4.1.1 Manual Ram Operation

The manual rams are operated by turning the drive shaft using a suitable tool (9/16'' Socket recommended) in a clockwise direction some 20-25 turns

4.1.2 Hydraulic Operation

The BOP has two pairs of connections for each ram set for open and close. It is important that both connections are connected, as the fluid displaced by the movement of the piston must be allowed to pass through the valve system back to the reservoir.

A Well Control Unit (WCU) is normally used to operate the BOP in an offshore environment. Refer to the relevant manual for that equipment for details of operation and connection. An alternative pump pack may be used for onshore maintenance work but the operation of this equipment is out with the scope of this manual.

4.1.3 Locking the Hydraulic Rams

After closing with hydraulic pressure the piston can be mechanically locked by winding in the manual mechanism. Turning the drive shaft in a clockwise direction will advance the locking mechanism by 3mm per turn. It is therefore necessary to turn the hand wheel 20-25 turns to lock in the piston. Continue to turn until the hand wheel stops, indicating that the piston is now against the back-up lock.

For safety reasons and to reduce the mechanical effort required, **Phuel recommends that the hydraulic pressure be removed or reduced while closing the mechanical back up**. This reduces the risk of injury caused by the failure of a seal under hydraulic pressure and decreases the time required to implement the back-up feature.

It is important to remember that the manual lock must be fully withdrawn before the rams can be opened.

4.1.4 Proper Use

In the event that the BOP is closed against wire during an operation, it is essential that the Inner seals are replaced after that job has been completed. Working practice and procedures must reflect this requirement.

Blind shear seals should always be fitted on the shear rams. They should be tested regularly to verify that they are suitable for operation. If they are ever closed during a live well operation they should be replaced when the operation is complete.

4.1.5 Bleed Down Rate in Gas Wells

To avoid explosive decompression in gas wells (or oil wells were there is a large quantity of gas present) it is important to control the bleed down rate of the pressure. The following procedure is recommended:

1. Reduce pressure from 10000 to 2000 Psi at a rate of 1000 psi per minute
2. Reduce pressure from 2000 psi to 1000 psi at a rate of 100 psi every one minute.
3. Reduce pressure from 1000 Psi to zero at a rate of 20 psi per minute.

4.2 Equalising across the rams

There is an external port that allows the connection of a pressure gauge or dump valve if required.

The number of valves actually available will depend on the BOP configuration. Valves #1 and #2 are always available but valve #U is only available in Dual and Triple configuration and Valve #L is only available in the Triple configuration. Other configurations are available if the standard set up does not meet the operational needs. Contact Phuel Oil Tools for advice if required.

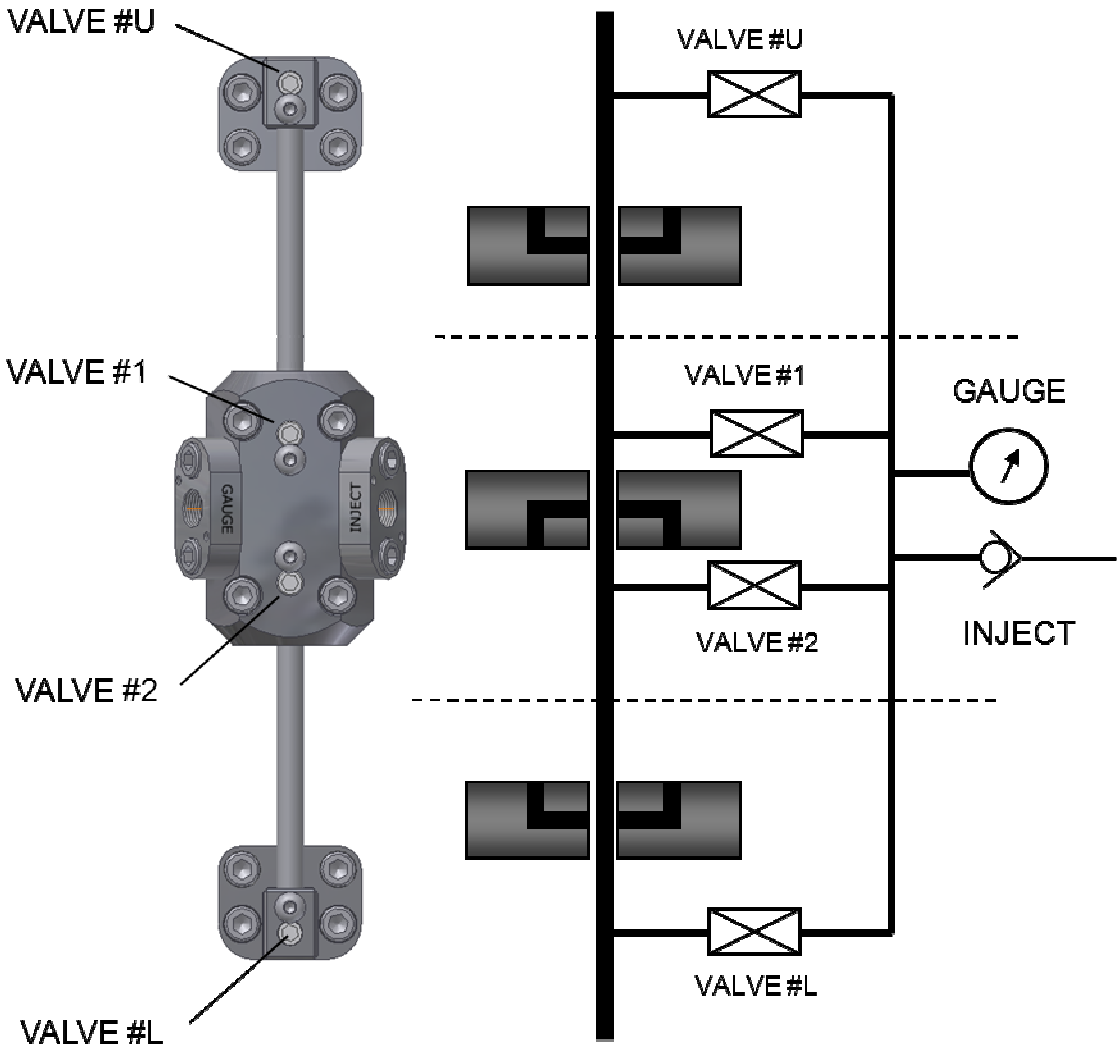


Figure 5: Equalisation Valve Layout

4.3 Job Planning

4.3.1 Before the Job

Note – Configuration will determine which processes are required

- Check that the certification is within date and that the scheduled maintenance is up to date.
- All blind (shear) inner seals need to be inspected after 30 pressure cycles, and replaced where necessary. Wire-line seals must be tested without the use of test rods and must always be replaced after being closed on wire during normal operations. Always inspect the wireline seals for signs of wear or damage and replace if necessary.
- Examine the BOP Assembly, to make sure that it is good operating order and assembled with the Rams in the correct orientation for the desired operation.
- Functioning of the Rams may be checked, by running both Rams to the closed position.

4.3.2 During the Job

- Special care should be taken that the Rams are fully open when passing any equipment through them. The impact of the tool string hitting a Ram may damage the Ram to such an extent that the Ram may no longer Seal, or prevents it from fully opening.
- Only lift the BOP using suitable lift caps. Do not sling or attach lifting equipment to the crash frame or bars to lift the BOP assembly.
- Care should be taken to completely remove any residual pressure or accumulated pressure existing on Lubricator equipment above the BOP, before disconnecting the Lubricator.
- Hydraulic Hose ends should never be allowed to drop in to dirt or grit, or otherwise become contaminated with foreign matter. If end connections become dirty, they should be cleaned thoroughly with solvent and dried.
- Only clean Hydraulic fluid should be used (Shell Tellus 22 is recommended) to operate the BOP. The use of mixed types, dirty, or very old fluid of unknown origin is not recommended. When one of these conditions is known or suspected, the hydraulic system should be flushed and the hydraulic fluid replaced.

4.3.3 After the Job

After each job, the BOP should be thoroughly cleaned, repaired as required and redressed.

The BOP should be protected against the effects of corrosion to ensure that the expected functionality is achieved. The diagram overleaf highlights the key areas to consider.

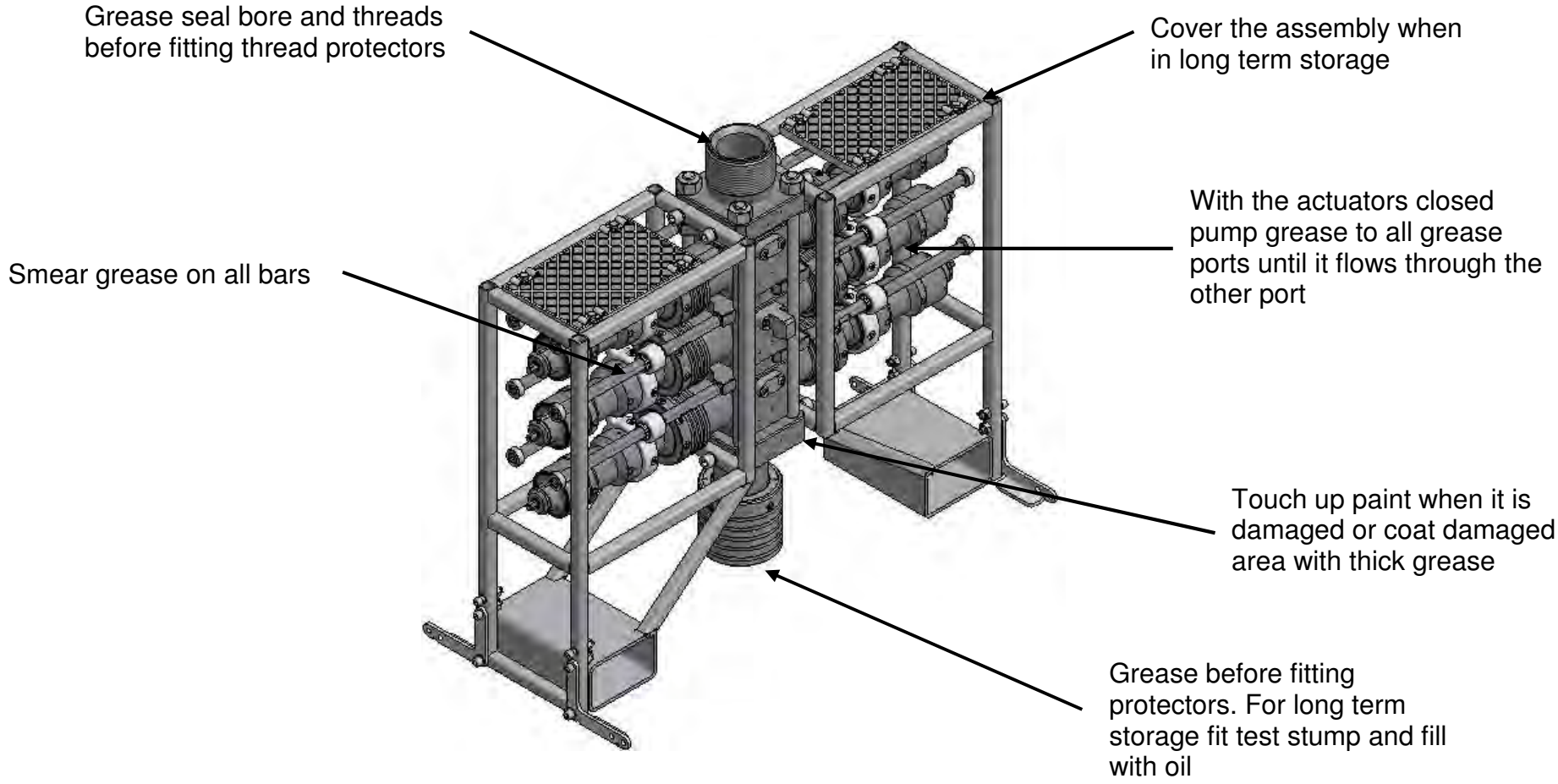

Grease seal bore and threads before fitting thread protectors
Cover the assembly when in long term storage
With the actuators closed pump grease to all grease ports until it flows through the other port
Smear grease on all bars
Touch up paint when it is damaged or coat damaged area with thick grease
Grease before fitting protectors. For long term storage fit test stump and fill with oil

Figure 6: Correct lubrication for storage

5 Operational Characteristics

5.1 Sealing Characteristics

5.1.1 Minimum Hydraulic Pressure

The actuator is pressure balanced and so it is possible to close the rams against any well pressure with more than 500 psi. In order to ensure that the BOP seals correctly it is recommended to apply the full closing pressure of 2900 psi (200 bar). In most cases the BOP will seal with pressures greater than 1,000 psi (70 bar) applied.

For a manual BOP the torque required to generate 1,000 psi is approximately 100 Nm (73 lbs-ft). As a general rule of thumb 100ft-lbs torque applied to the manual actuator is equivalent to 100 bar when applied with a hydraulic actuator.

5.1.2 Opening the BOP with differential pressure

It is not recommended that the BOP should be opened with differential pressure across the rams. The pressure should always be equalised first, using the equalising valves.

Even with differential pressure applied across the rams it is possible for the BOP to be opened if the opening pressure is greater than 1400 psi. The manual locking feature should therefore be used when the BOP is closed to prevent accidental opening

5.2 Fatigue Testing

Testing has been performed to establish the fatigue limit of the actuators and shear rams so that preventative maintenance can be scheduled to replace worn seals or parts.

A total of 546 close/open cycles have been completed without failure including 78 pressure cycles to maximum working pressure. This test simulates closing and opening the BOP once per day and testing well bore pressure at 300 psi and 10,000 psi once per week for 1.5 years of service. Records must be maintained to ensure that the seals are replaced before this limit is exceeded. If records do not exist then the seals should be changed every year as a minimum.
Fatigue life has not been defined on the wireline seals due to their less critical function and the fact that these are to be replaced whenever they are closed

on the wire. Pre-job inspection to verify their condition is therefore required and replacement if they are not in good physical condition.

5.3 Ram Access Testing

Testing has been performed to determine the ability of the BOP to undergo repeated ram changes without affecting operating characteristics. The tests have shown that the rams were accessed a total of 200 times (test limit) without failure of the sealing or locking mechanism. Records must be maintained to ensure that the seals are replaced before this limit is exceeded. If records do not exist then the seals should be changed every year as a minimum.

5.4 Shearing Performance and limitations

Testing has been conducted to verify the shearing and sealing capabilities of the shear rams. The minimum tool string weight must be achieved either by direct weight or the combination of that and additional tension to ensure that the cutting performance is achieved.

Wire Size (dia)	No of wires	Wire Type	Minimum Tool String Weight	Hydraulic Pressure needed to shear at zero bore pressure	Maximum Wellbore Pressure (psi)
0.125”	1	Slick line	250 Kg	1060 psi	10,000 psi
0.125”	6	Slick line	250 Kg	2120 psi	10,000 psi
0.160”	1	Slick line	250 Kg	1670 psi	10,000 psi
7/32”	1	Braided	250 Kg	1060 psi	10,000 psi
7/32”	2	Braided	250 Kg	1700 psi	10,000 psi
9/32”	1	Braided	250 Kg	1670 psi	10,000 psi
5/16”	1	Braided	250 Kg	1700 psi	10,000 psi
7/16”	1	Braided	250 Kg	2970 psi	10,000 psi
15/32”	1	Braided	250 Kg	2970 psi	10,000 psi

Table 2: Shearing performance and limitations

Note – The shear rams are designed to cut only once. The rams must be replaced once they are used to cut wire.

5.5 Performance of Ram Guides

Testing has been conducted to verify that the wireline rams can centralise the cable without cutting – at extreme wire positions and with applied side loadings. The rams always closed without incident or damage to the cable. Operational planning and set up should still attempt to minimise the expected

side loading on the wire by ensuring the lubricators are vertical and that the tool string is centralized as much as possible in the well bore.

5.6 Temperature and Pressure Limitations

Testing has been conducted to verify the performance of the BOP at extreme operating temperatures.

5.6.1 General Sealing

The BOP seals (typically O-Rings and T-Seals of 90 hard Viton material with part numbers listed in this manual) have been qualified for operating temperatures between -10C and 121C with no restrictions to the operating pressure.

5.6.2 Blind Ram Shear Seals

The shear rams (using blind ram inner shear seals part number 190-4141-H80 & 190-4142-H80) have been qualified for operation between -10C and 121C with no restrictions to the working pressure.

5.6.3 Wireline Multi-Seals

The wireline multi-seal (part number 190-4170-H80 & 190-4171-H80) are qualified to be used within the operating envelope shown below. If operations dictate that the expected surface temperatures and pressures exceed the operating envelope then wire specific inner seals must be used instead of the standard multi-seal. Consult Phuel Oil Tools for advice and part numbers.

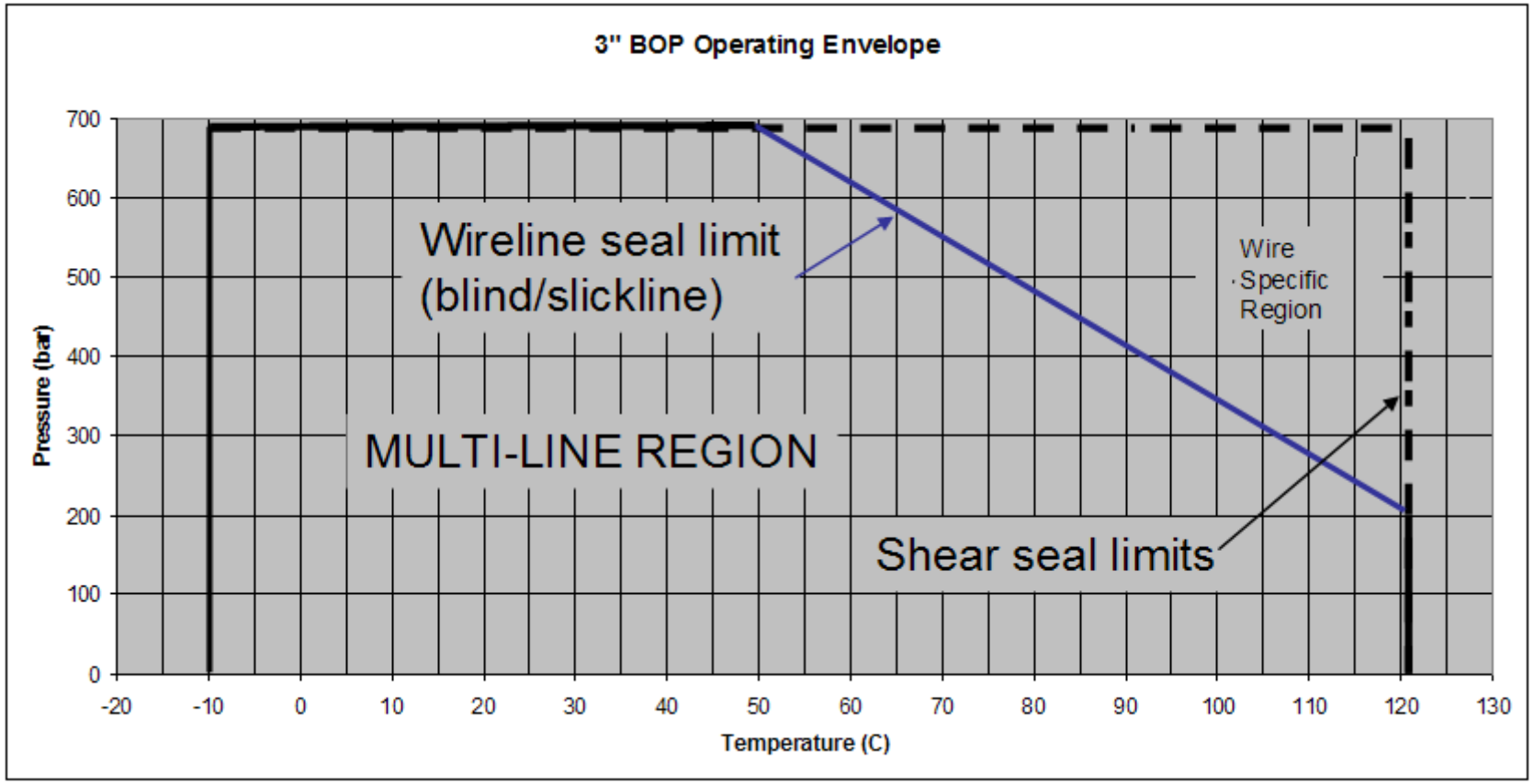


Figure 7: Qualified Operating Envelope

6 Maintenance

All maintenance to be carried out by suitably qualified and competent personnel

6.1 Introduction

Regular maintenance of the equipment using Phuel redress kits or approved spares is essential to its continued safe operation. Ensure that the pre and post job operating procedures are followed and that maintenance records are kept.

6.2 Schedule

The maintenance schedule may be governed by international or company standards and the following is considered to be the minimum requirements.

6.2.1 Pre & Post Job

Refer to Section 4.3.1 and Section 4.3.3 for details.

6.2.2 Yearly

- Visually inspect the BOP for signs of wear or damage
- Close the rams with 3,000 psi and hold for 10 minutes with no leaks allowed. Open the rams with 3,000 psi and hold for 10 minutes with no leaks allowed. If there are leaks then the actuators will need to be dis-assembled and the seals replaced.
- Disconnect the actuators and inspect the rams (guides and seals). Replace the seals if they are worn or damaged. Re-assemble
- Re-apply grease to the balanced piston, ref Figure 18
- Verify that the equalising valves are moving freely and smoothly
- Verify that the tie bolt nuts and all other screws are tight
- Remove external rust or treat using a non-toxic rust remover gel or liquid.
- Inspect the condition of quick union sealing surfaces and surface coatings, repair/replace as necessary.
- If any of the above are showing signs of wear or damage then strip down to investigate and replace parts or seals as necessary.
- Re-assemble and then pressure test according to Section 7
- Inspect paintwork and repair where necessary.

6.2.3 Five Yearly

- Recertification by Phuel Oil Tools in accordance with DNV-RP-E101

6.3 Safety

- This product contains high pressures, when in operation. Failure of any part may cause injury. Welding, corrosion, rough handling, or other abuse may affect the Integrity of this product.
- Wear appropriate personal protective equipment.
- Do not over exert yourself while using torque wrenches. Use appropriate mechanical advantages when available.
- Ensure that all tools and equipment are in good condition and are suitable for intended use.

6.4 Ram Seal Redress

Note: If rams are required to be removed ensure they can be moved fully forward when the time comes.

6.4.1 Access Rams

This procedure results in the disconnection of the actuator assembly from the BOP body in order to gain access to the rams.

- Ensure Rams are fully opened.
- Back off the Actuator from the BOP using the extended 5/16" Allen Key in the Cap Screw heads on the Locking Sleeve. Do not loosen the cap screws during this process.
- Once the thread is fully disengaged, pull the Actuator fully back to the End Stops.

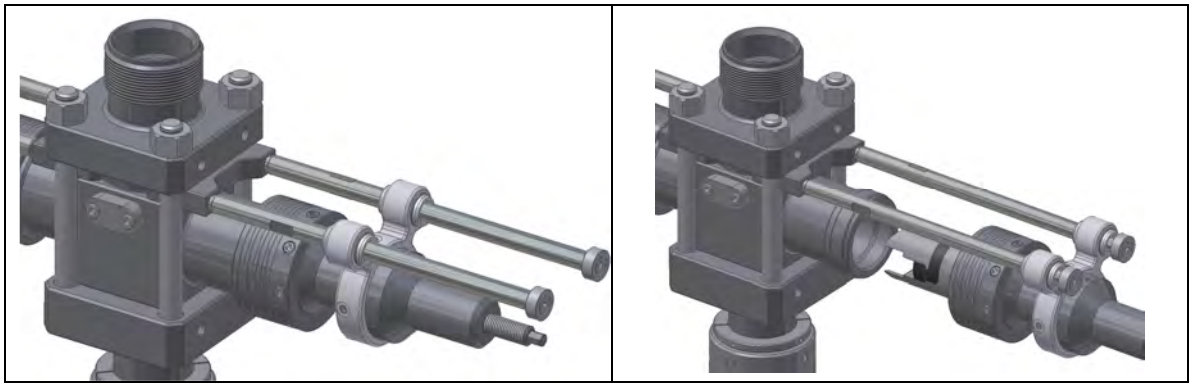


Figure 9: Accessing the rams

6.4.2 Ram Removal (not required to redress ram seals)

- Pump or manually wind the actuator forward until the back of the ram is clear of the Collar
- Undo guide bar, ensuring the nordlok washer remains in the actuator piston housing, and slide into ram
- Remove Ram from Actuator, by sliding the Ram off the Piston.

6.4.3 Ram Seal Redress

- The Inner Ram Seals can be removed by simply sliding the seal out to either side
- The Outer Seal can be removed by levering out one end with a suitable instrument and simply pulling off.
- The Ram is now completely stripped down. Clean and inspect all parts for evidence of damage or excessive wear. Check the seals and replace if required. Repair or replace any damaged or worn parts. If the seals are to be redressed use the parts from the specified redress kit.
- Assemble Outer Seals by pushing the tab into the slot in the ram and working it around the radius of the ram. Tap home using a rubber or hide mallet and if required use a screwdriver to lever the second tab over the edge of the slot. Take care not to damage the Seal during assembly but expect that some slithers of rubber will be produced as the corners of the rubber seals are removed by the assembly operation. Tap all around the circumference of the seal to ensure that it is bedded into the groove and that the seal is not protruding above the ram diameter.
- Slide the Inner Seals into Ram taking care not to dislodge the outer seal in the process. Ensure the Guided Inner Seal is fitted to the correct ram as shown below.

Figure 10: BOP Wireline Rams

Figure 11: BOP Shear Rams

6.4.4 Re-attach to BOP Body

- If the rams were removed from the actuator (Section 6.4.2) then slide the ram back onto the actuator and guide bar out of the ram and attach the bar back to the piston housing taking careful note of the orientation of the rams depending on its intended use for the BOP assembly. (i.e. if pressure is to be held from below then the outer seal must be on top – otherwise it must be on the bottom). Attach a hydraulic pump, if required, to the open port of the actuator and pump or manually wind the rams back into the recess in the actuator ensuring that the ram does not hang up on the actuator front face. When fully back remove the hydraulic pump.

Note - It is still possible to assemble the actuator to the BOP without pumping back the rams but more effort may be required to allow the thread to make up.

- Apply a generous coating of grease to the inner and outer seals.
- Push the Actuator back into BOP Body taking care that the edges of the guide pass into the seal bore and make-up the thread using a 5/16” hex key in the cap head screws to provide the torque. Making up the thread will drive the actuator assembly fully home.
- The Ram Assembly is now fully made up. Repeat this procedure for each ram seal that need to be replaced.

6.5 Modular Connection

The Modular BOP allows modules to be separated and re-configured to suit operation needs. Follow this procedure to split and re-make the modules as required.

Note – This must be carried out in a workshop environment with pressure testing facilities by suitably qualified personnel

6.5.1 Splitting the Connection

- Locate and remove the 4 Tie Bar Nuts
- The two assemblies can now be pulled apart
- Inspect the T-Seal and replace if necessary

6.5.2 Re-Making the Connection

Note - Take note of new body serial number to allow update of traceability

- Ensure that the T-Seals are in good condition
- Ensure correct length of Tie Bars are fitted for the amount of modules to be fitted
- Lower the upper module down over the Tie Bars
- Fit 4 Tie Bar nuts and tighten to a Torque of 686 lbft (925 Nm)
- Carry out pressure testing to maximum working pressure see Test Procedure below
- Update paperwork with new numbers for traceability

6.6 Special Tools

General workshop tools will be required to maintain, and assemble and disassemble the BOP.

To undo and tighten the balanced piston from the hydraulic piston, two hex keys are required, 3/8" and 1-1/8". Phuel can supply a Hex bar to fit this piston and allow a 1-1/8" socket to be connected.

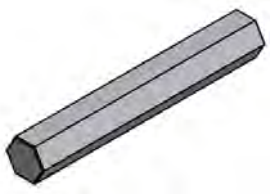


Figure 12: 950-4656-316 - Piston Assembly Tool

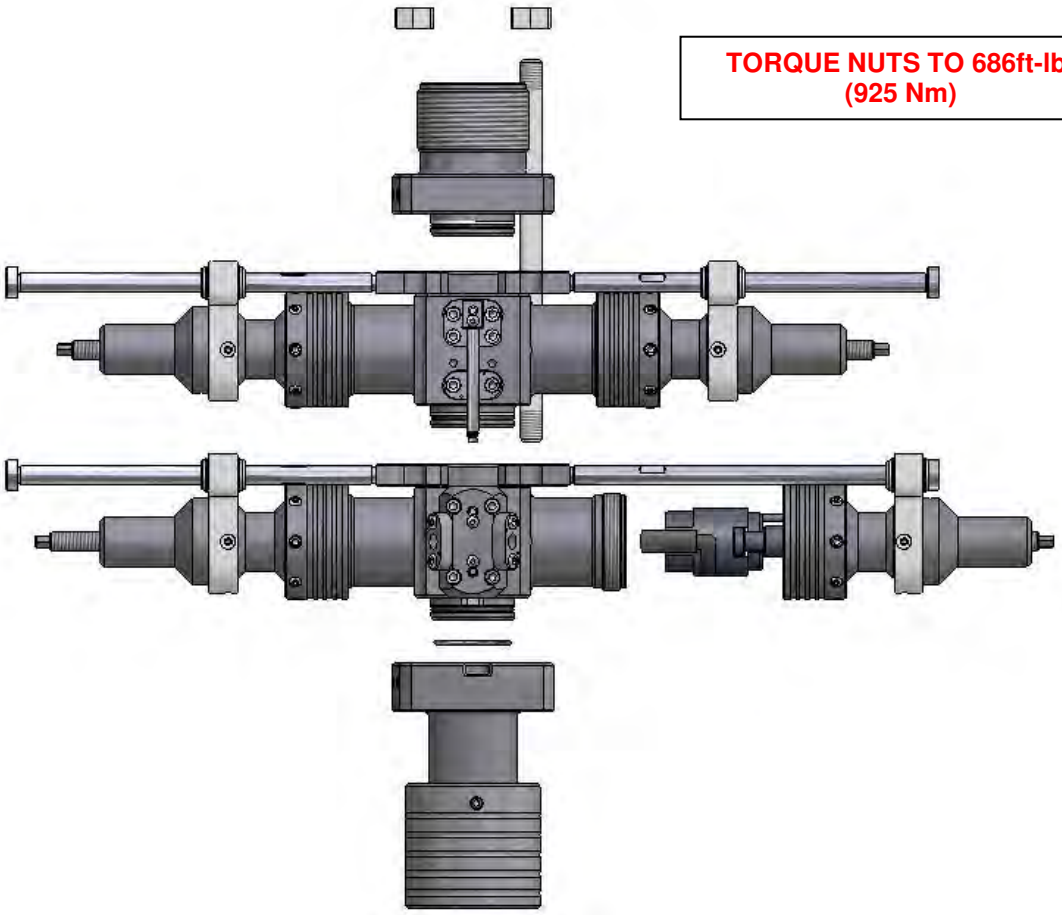


Figure 13: Connecting Multiple Modules

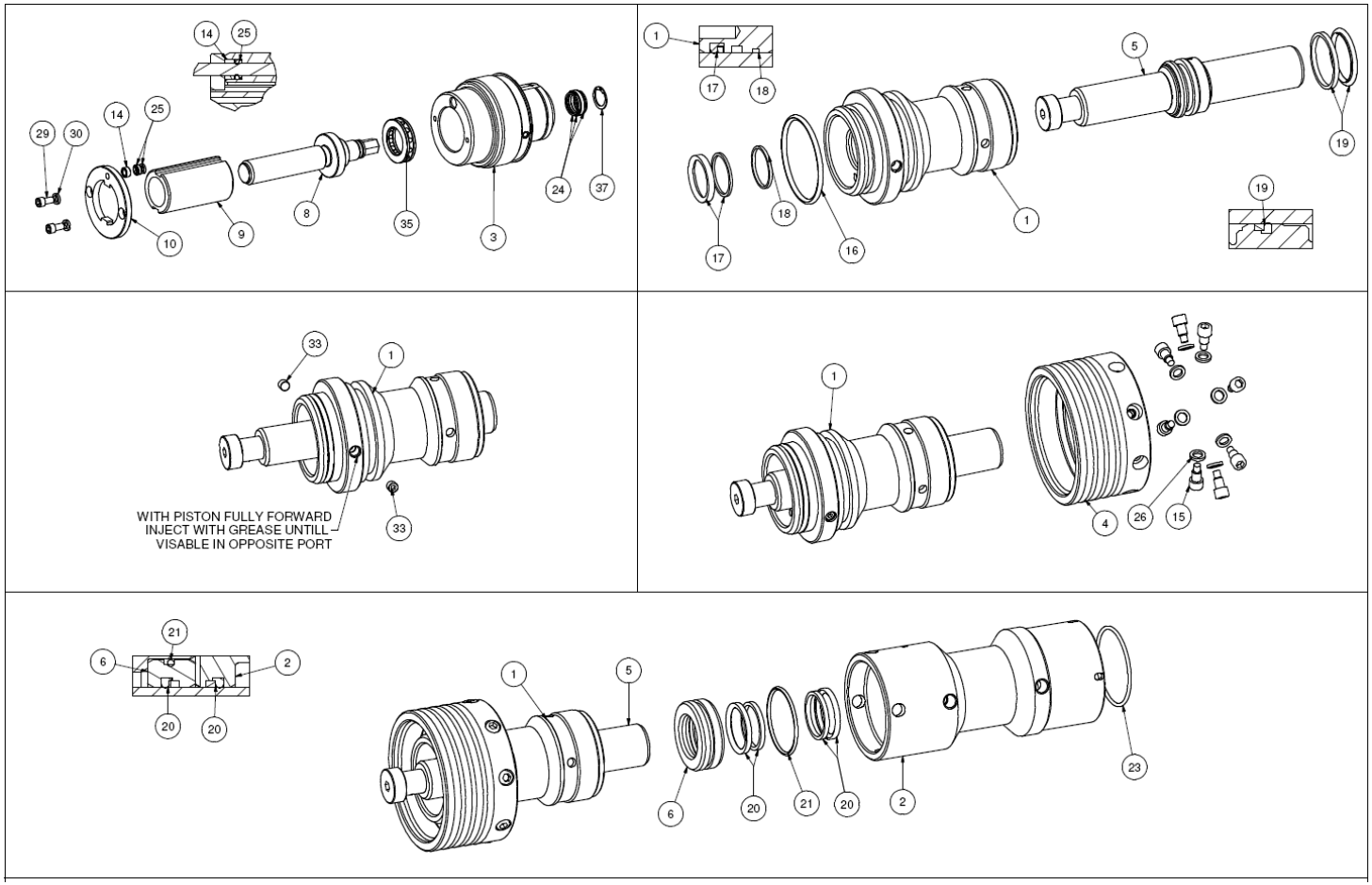


Figure 14: Hydraulic Actuator Assembly (Part 1)

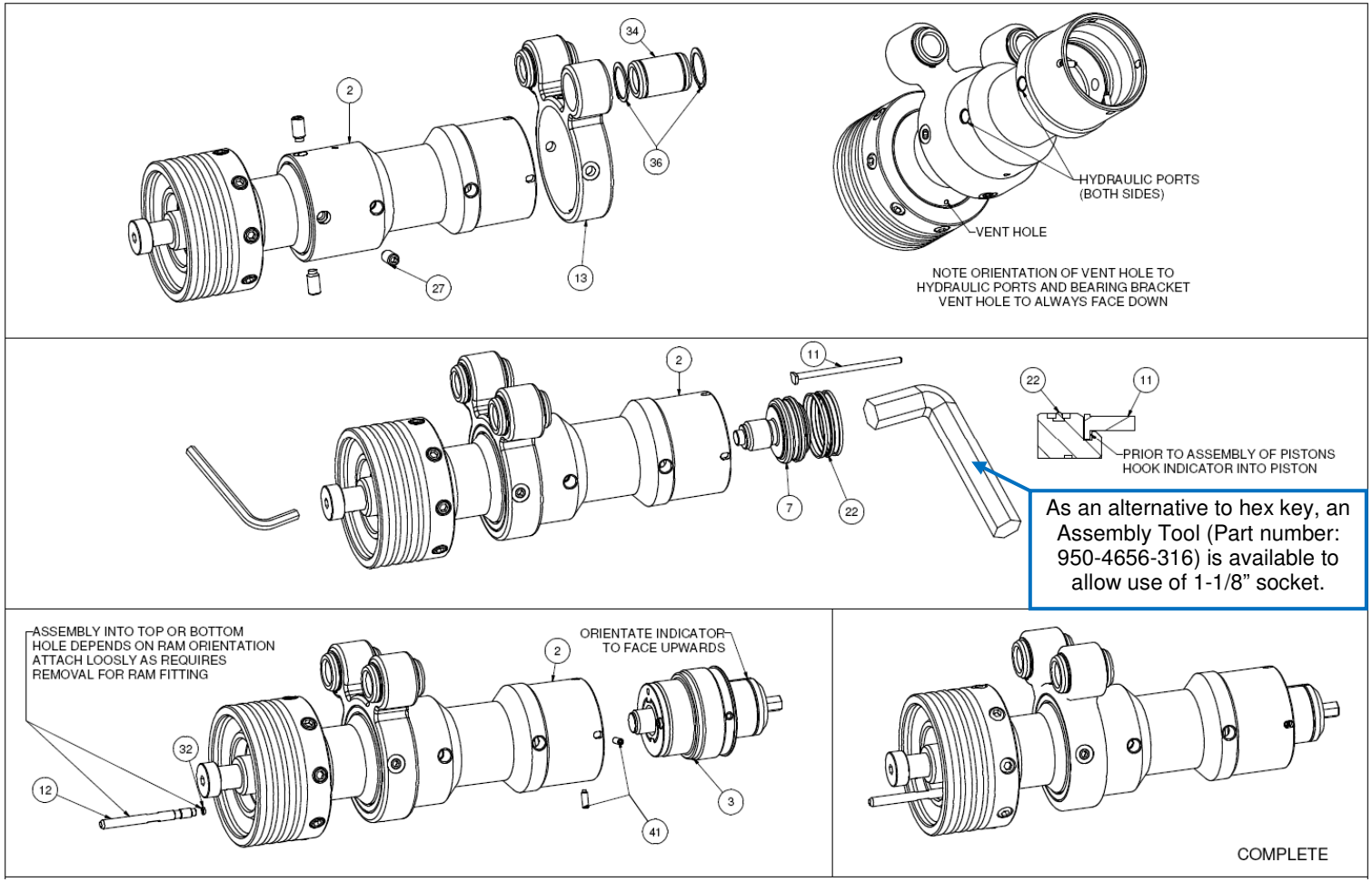


Figure 15: Hydraulic Actuator Assembly (Part 2)

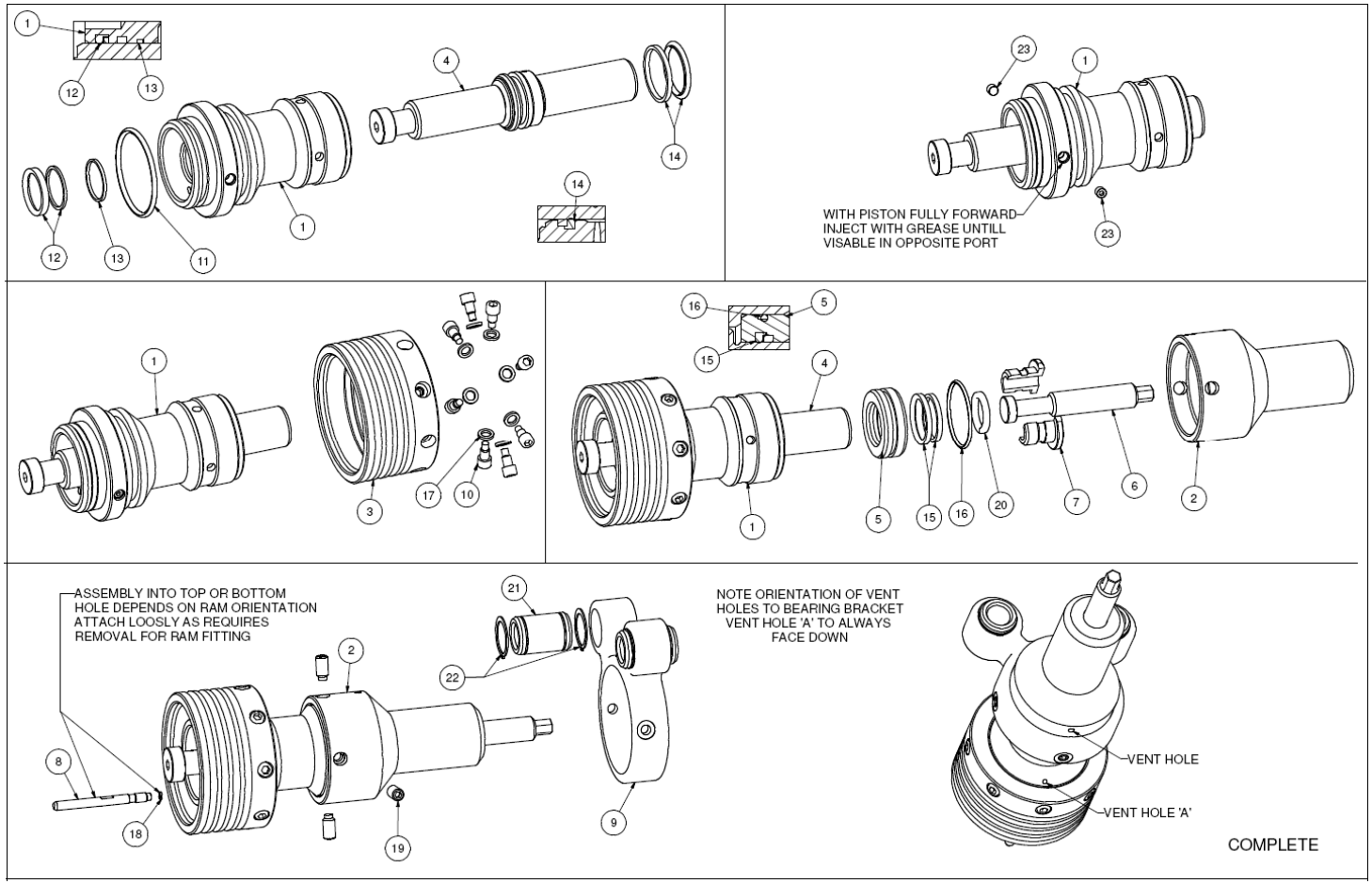


Figure 16: Manual Actuator Assembly

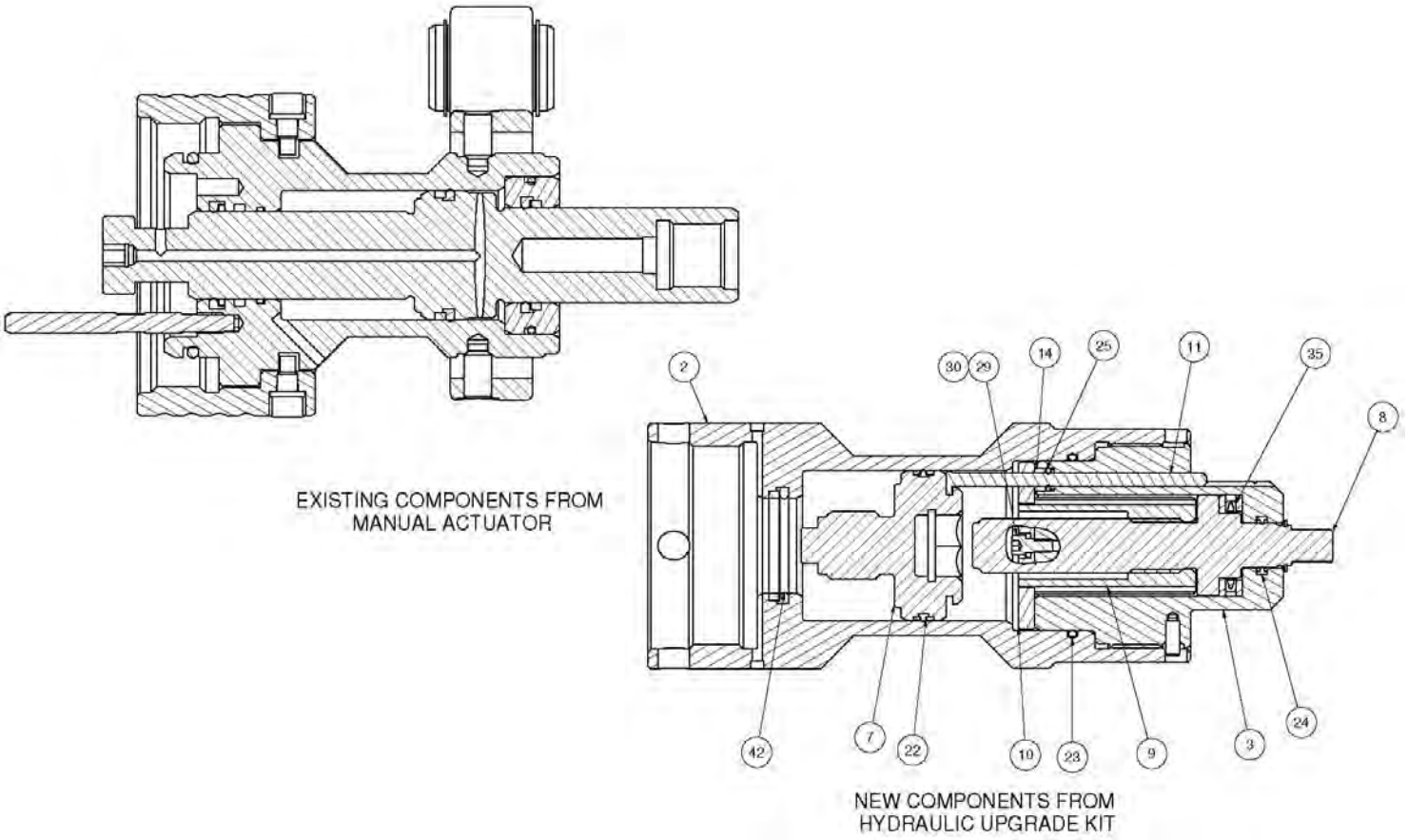


Figure 17: Manual/Hydraulic Conversion

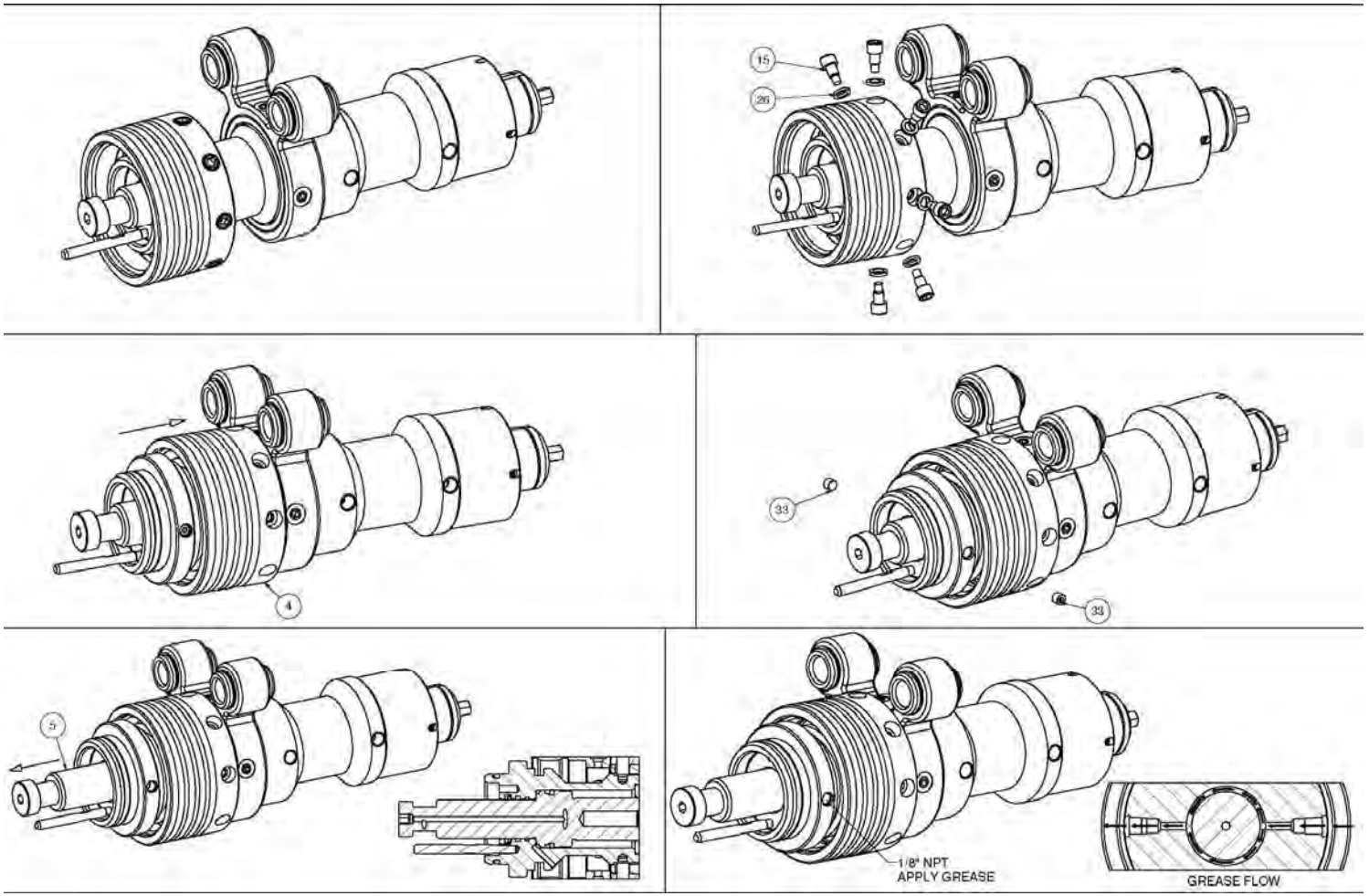


Figure 18: Instructions for greasing of the Piston Shaft

6.7 Maintenance Record Sheet

Date Performed	Type of Maintenance	Performed By	Verified By	Comments

Example

Table 3:Maintenance Record

7 Testing

All testing is to be carried out in the designated test area and by suitably qualified and competent personnel. Safety procedures must be followed.

7.1 Hydraulic BOP

Check the build configuration then adapt the procedure to test using the procedures laid out below for a Dual BOP.

7.1.1 Prepare for pressure testing

- Check the pressure rating for all test equipment is sufficient to allow testing to be carried out.
- Check / replace o-ring on the pin part of the quick union connection.
- Ensure valve is placed in an area suitable for pressure testing.
- Fit the valve to the test stump.
- Makeup valve (collar) on test stump by turning the "collar" all the way down, and then back off ¼ turn
- Fit the test hose to the Gauge port on the Equalizing Block.
- Do not fit anything to the Inject port so as to test the check valve.
- Fill valve with test fluid.
- Connect the hydraulic hoses from the BCU to valve to operate the rams.
- Check all connections / hoses that they are secured with safety wire before use
- Vent behind the rams by opening and closing all the rams a few times each.
- On completion of venting the rams fit test cap, ensuring the test cap valve is in the open position to allow air to vent and top up the valve with test fluid. Once all air is expelled close test cap valve.
- The valve is now prepared for testing

7.1.2 Body Test

- Ensure that all the rams are in the open position
- Open all the equalizing valves.
- Pump slowly up to 300 psi and observe for leaks. Hold Time 5 min with no leaks
- Bleed the pressure to zero
- Pressurize to MWP in accordance with documentation and observe for leaks. Hold Time 15 min with no leaks
- Bleed of pressure to zero.

7.1.3 Lower Ram Test:

- Close Lower Ram, this is done by activating the BCU Lower ram valve to "close" position, then pressurize up to a maximum of 3,000 psi on the ram.
- Close valves #1 and #U and open valve #2 so that pressure testing is done from the underside of rams and up
- Pressurize up to 300 psi low pressure test - observe if there are leaks. Hold Time 10 min with no leaks
- Bleed the pressure to zero
- Pressurize up to the MWP in accordance with documentation – maintain the pressure for 10 min without leaks.
- Bleed the pressure to zero.
- Open the lower rams by enabling BCU Lower ram valve to "open" position.

7.1.4 Upper Ram Test:

- Close Upper Ram, this is done by activating the BCU Upper ram seal valve to "close" position, then pressurize up to a maximum of 3,000 psi on the ram.
- Close valves #1 and #U and open valve #2 so that pressure testing is done from the underside of rams and up
- Pressurize up to 300 psi low pressure test - observe if there are leaks. Hold Time 10 min with no leaks
- Bleed the pressure to zero
- Pressurize up to the MWP in accordance with documentation – maintain the pressure for 10 min without leaks.
- Bleed the pressure to zero.
- Open upper rams by enabling BCU Upper ram valve to "open" position.

7.2 Post Test Procedure

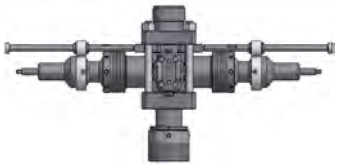
- Disconnect All Hoses
- Remove Test Cap
- Drain out test fluid and circulate with water displacing fluid or lubricating oil
- Re-fit the gauge to the Equalising Block if required or re-fit the check valve if removed earlier.
- Remove BOP from Test Stump
- Grease end connections and fit oiled thread protectors

8 Parts List and Drawings

MANUAL ACTUATORS

HYDRAULIC ACTUATORS

SINGLE



Redress Kits
1x RDK-4329-HV0 (Body & Actuators)
1x RDK-4450-HV1 (Injection)
1x RDK-4360-HH0 (Wireline Rams)
1x (Top & Bottom Subs – see Table 4)

Conversion Kit
2x KIT-4298-HV0
Hydraulic Fittings 1x
190-4433-HS#

Redress Kits
1x RDK-4328-HV0 (Body & Actuators)
1x RDK-4450-HV1 (Injection)
1x RDK-4360-HH0 (Wireline Rams)
1x (Top & Bottom Subs – see Table 4)

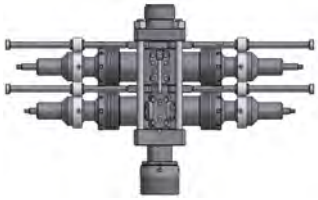
Additional Modules Required
196-4329-HV0 (Body & Actuators)
192-4450-KIT (Injection)
192-4330-SS0 (Tie-Bars)
190-4360-HH0 (Wireline Rams)

Additional Modules Required
196-4328-HV0 (Body & Actuators)
192-4450-KIT (Injection)
192-4330-SS0 (Tie-Bars)
190-4360-HH0 (Wireline Rams)
Hydraulic Fittings (see table ##)

Additional Modules Required
191-4330-SS0 (Tie-Bars)
190-3161-HV0 (Bank Port End)

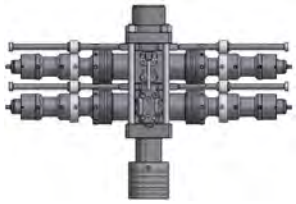
Additional Modules Required
191-4330-SS0 (Tie-Bars)
190-3161-HV0 (Bank Port End)

DUAL



Redress Kits
2x RDK-4329-HV0 (Body & Actuators)
1x RDK-4450-HV2 (Injection)
2x RDK-4360-HH0 (Wireline Rams)
1x (Top & Bottom Subs – see Table 4)

Conversion Kit
4x KIT-4298-HV0
Hydraulic Fittings 2x
190-4433-HS#



Redress Kits
2x RDK-4328-HV0 (Body & Actuators)
1x RDK-4450-HV2 (Injection)
2x RDK-4360-HH0 (Wireline Rams)
1x (Top & Bottom Subs – see Table 4)

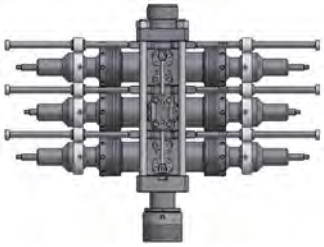
Additional Modules Required
196-4329-HV0 (Body & Actuators)
193-4450-KIT (Injection)
193-4330-SS0 (Tie-Bars)
190-4359-HH0 (Shear Rams)

Additional Modules Required
196-4328-HV0 (Body & Actuators)
193-4450-KIT (Injection)
193-4330-SS0 (Tie-Bars)
190-4359-HH0 (Shear Rams)
Hydraulic Fittings (see table ##)

Additional Modules Required
192-4330-SS0 (Tie-Bars)
190-3161-HV0 (Bank Port End)

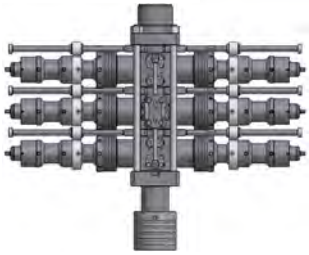
Additional Modules Required
192-4330-SS0 (Tie-Bars)
190-3161-HV0 (Bank Port End)

TRIPLE



Redress Kits
3x RDK-4329-HV0 (Body & Actuators)
1x RDK-4450-HV3 (Injection)
2x RDK-4360-HH0 (Wireline Rams)
1x RDK-4359-HH0 (Shear Rams)
1x (Top & Bottom Subs – see Table 4)

Conversion Kit
6x KIT-4298-HV0
Hydraulic Fittings 3x
190-4433-HS#



Redress Kits
3x RDK-4328-HV0 (Body & Actuators)
1x RDK-4450-HV3 (Injection)
2x RDK-4360-HH0 (Wireline Rams)
1x RDK-4359-HH0 (Shear Rams)
1x (Top & Bottom Subs – see Table 4)

Part Number	Description
196-4324-HV0	MODULAR TOP SUB ASSY 4-3/4
196-4325-HV0	MODULAR BOTTOM SUB 4-3/4
RDK-4325-HV0	4-3/4 BOTTOM SUB REDRESS KIT
196-4326-HV0	MODULAR TOP SUB ASSY 5-3/4
196-4327-HV0	MODULAR BOTTOM SUB ASSY 5-3/4
RDK-4327-HV0	5-3/4 BOTTOM SUB REDRESS KIT

Table 4: Available Top & Bottom Sub Assemblies

Part Number	Description
190-4433-HS0	HYDRAULIC KIT (BEATTIE QR 74)
190-4433-HS1	HYDRAULIC KIT (SNAP TITE HC-44)

Table 5: Available Hydraulic Connection Kits

New items can be made available upon request.
Contact Phuel Oil Tools with your requirements

Item	Part Number	Quantity	Description
1	196-4329-HV0	1	3" MOD BOP WITH MANUAL ACTUATORS
2	196-4324-HV0	1	3" MODULAR TOP SUB ASSY 4-3/4
3	196-4325-HV0	1	3" MODULAR BOTTOM SUB 4-3/4
4	191-4330-SS0	1	3" MOD SINGLE TIE BARS
6	190-4360-HH0	1	MODULAR 3" GUIDE RAM ASSEMBLY
7	191-4450-HV0	1	3" MOD SINGLE INJECTION MODULE

Table 6: Single BOP 4-3/4 -4 (Manual) Parts List – 191-4331-HV0

Item	Part Number	Quantity	Description
1	196-4328-HV0	2	3" MOD BOP WITH HYDRAULIC ACTUATORS
2	196-4324-HV0	1	3" MODULAR TOP SUB ASSY 4-3/4
3	196-4325-HV0	1	3" MODULAR BOTTOM SUB 4-3/4
4	192-4330-SS0	1	3" MOD DUAL TIE BARS
6	190-4360-HH0	2	MODULAR 3" GUIDE RAM ASSEMBLY
7	192-4450-HV0	1	3" MOD DUAL INJECTION MODULE
8	190-4433-HS1	2	3" Mod Hydraulic Kit (Snap Tite)

Table 7: Dual BOP 4-3/4 -4 (Hydraulic) Parts List – 192-4490-HV0

Item	Part Number	Quantity	Description
1	196-4328-HV0	3	3" MOD BOP WITH HYDRAULIC ACTUATORS
2	196-4326-HV0	1	3" MODULAR TOP SUB ASSY 5-3/4
3	196-4327-HV0	1	3" MODULAR BOTTOM SUB ASSY 5-3/4
4	193-4330-SS0	1	3" MOD TRIPLE TIE BARS
5	190-4359-HH0	1	MODULAR 3" SHEAR RAM ASSEMBLY
6	190-4360-HH0	2	MODULAR 3" GUIDE RAM ASSEMBLY
7	193-4450-HV0	1	3" MOD TRIPLE INJECTION MODULE
8	190-4433-HS1	3	3" Mod Hydraulic Kit (Snap Tite)

Table 8: Triple BOP 5-3/4 -4 (Hydraulic) Parts List – 193-4498-HV0

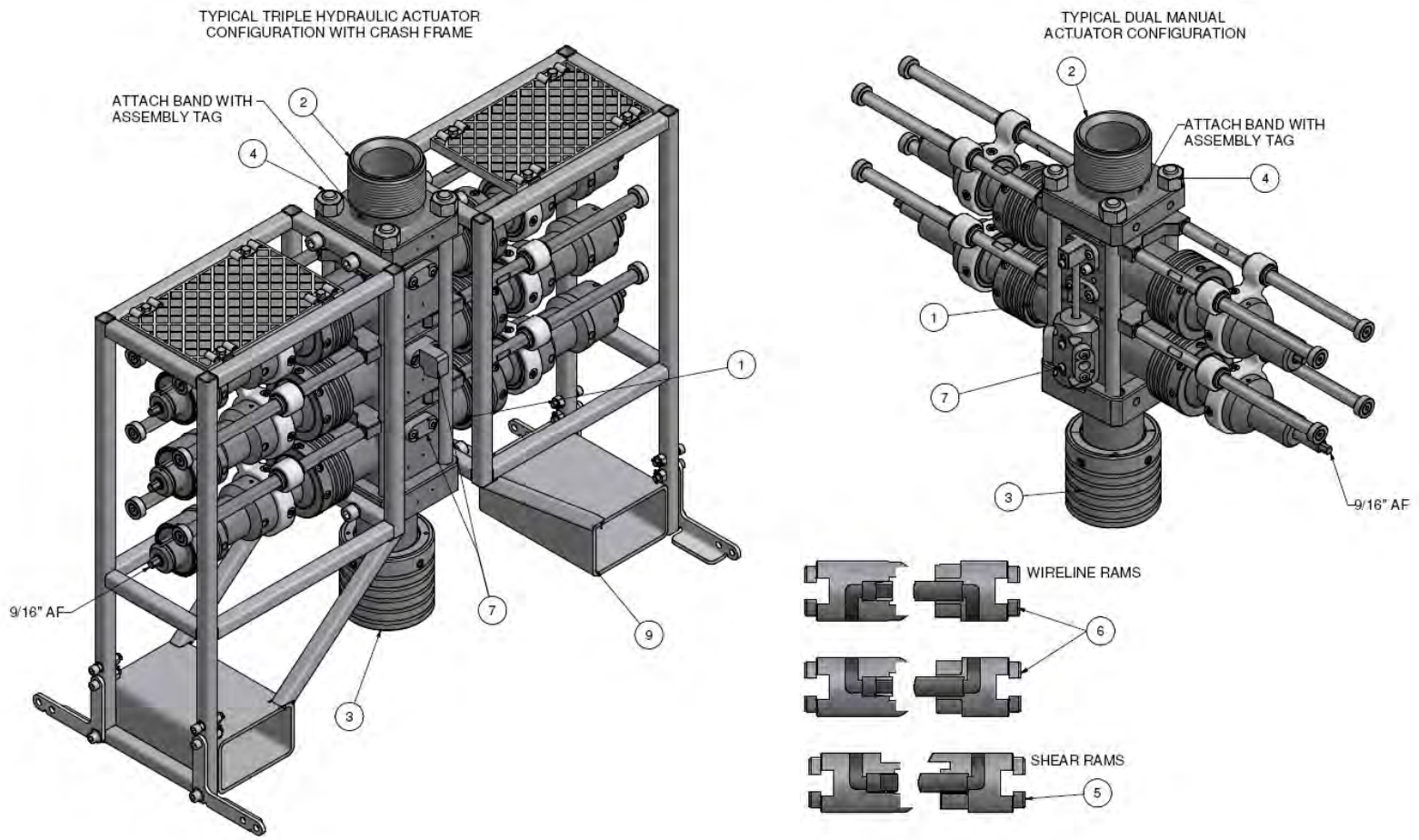


Figure 19: Typical Configuration of Modular BOP (All versions)

Item	Part No	Qty	Description
1	196-4210-480	1	3" MODULAR BODY
2	190-4299-HV0	2	3" MOD MANUAL ACTUATOR
3	190-4276-X90	4	3" MOD SLIDER ROD
4	190-4280-STL	2	SLIDER ROD BLOCK
5	190-1672-316	4	END STOP
6	CSU-0585-3A4	4	CSink Soc Hd Size 1/2 Length 1 in
7	802-4390-H85	1	PISTON T-SEAL 4.300

Table 9: 3’’ Modular Body Parts List Manual

Item	Part No	Qty	Description
1	196-4210-480	1	3" MODULAR BODY
2	190-4289-HV0	2	3" MOD PISTON ACTUATOR
3	190-4276-X90	4	3" MOD SLIDER ROD
4	190-4280-STL	2	SLIDER ROD BLOCK
5	190-1672-316	4	END STOP
6	CSU-0585-3A4	4	CSink Soc Hd Size 1/2 Length 1 in
7	802-4390-H85	1	PISTON T-SEAL 4.300

Table 10: 3’’ Modular Body Parts List Hydraulic

Note: to aid calculation of make-up length the Modular Body is 6.875’’ High

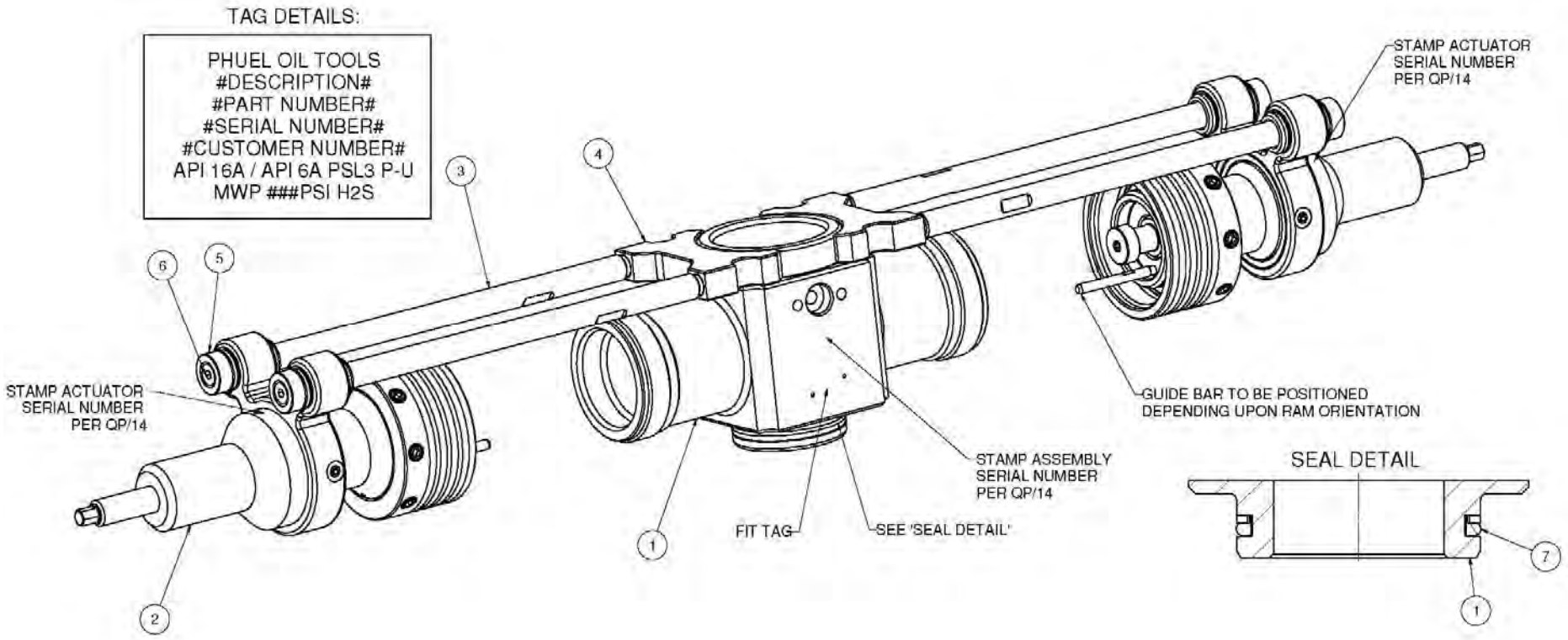


Figure 20: 3’’ Modular Body Manual

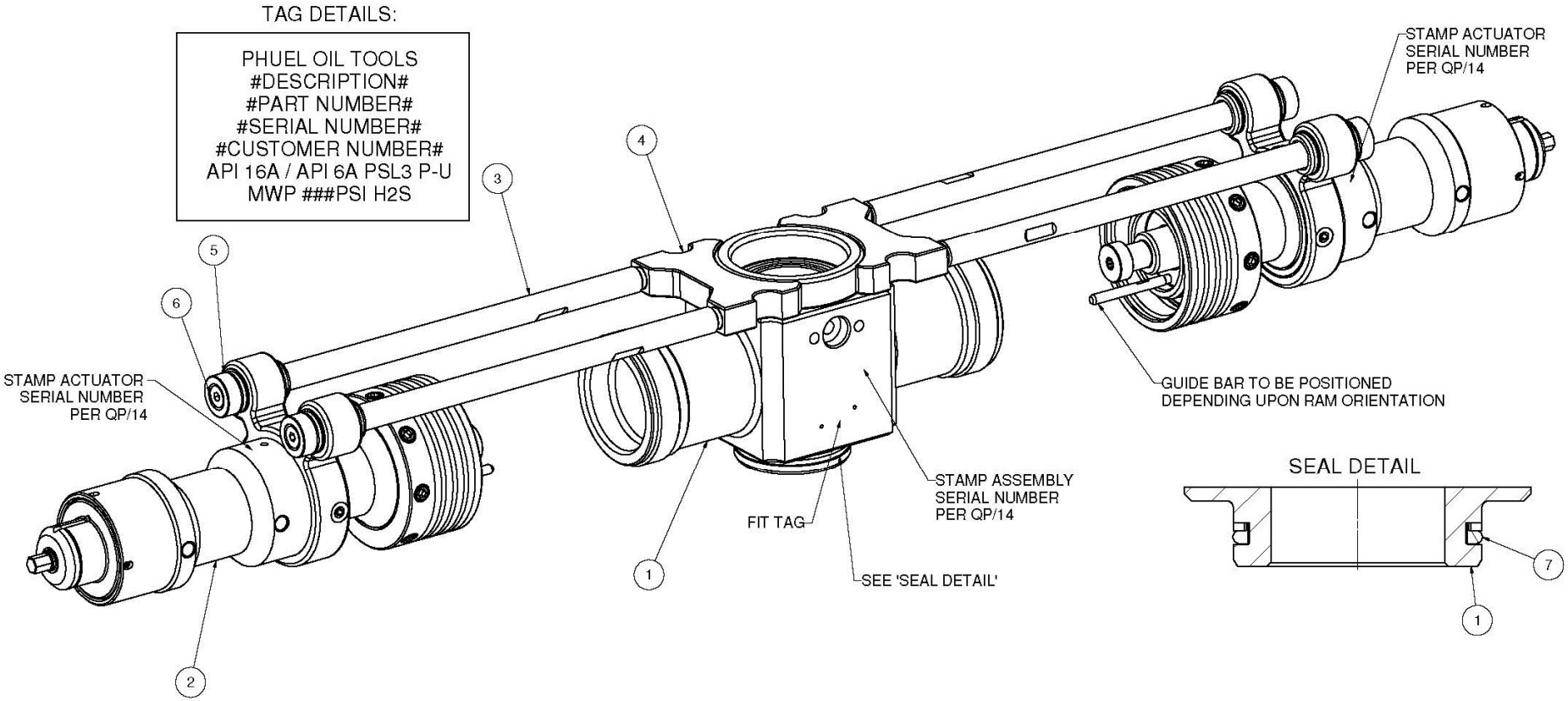


Figure 21: 3'' Modular Body Hydraulic

Item	Part Number	Quantity	Description
1	190-4277-480	1	3" MOD PISTON HOUSING
2	190-4293-480	1	3" MOD MANUAL CYLINDER CAP
3	190-4198-480	1	3" MOD ACTUATOR COLLAR
4	190-4278-480	1	3" MOD BALANCED PISTON
5	190-4201-480	1	3" MOD SEAL RING
6	190-4297-480	1	3" MOD MANUAL DRIVE SHAFT
7	190-4298-480	1	3" MOD MANUAL DRIVE SHAFT RETAINER
8	190-4290-480	1	3" RAM GUIDE BAR
9	190-4202-ALU	1	3" MOD BEARING BRACKET
10	190-4335-316	8	COLLAR BOLT 3" MOD
11	801-0340-V90	1	O-Ring - B.S Size 340
12	190-3870-H85	1	ROD SEAL
13	190-4343-PEK	1	GREASE SCRAPPER RING
14	802-4340-H85	1	PISTON T-SEAL 2.385
15	802-4339-H85	1	ROD T-SEAL 1.750
16	801-0231-V90	1	O-Ring - B.S Size 231
17	WNL-0540-316	8	Nord Lock Washer Size 3/8
18	WNL-3703-316	1	NORDLOCK WASHER M4
19	SDU-0585-316	4	Set Screw Dog Point 1/2 UNC X 1.000 in
20	WNL-4344-316	1	NORD LOCK WASHER M30 (1.125")
21	190-1608-STL	2	Ball Slide (TK-25-UU)
22	190-1756-STL	4	EXTERNAL CIRCLIP (EXT-0400)
23	100-2209-316	2	NPT SOCKET HEAD PLUG 1/8

Table 11: Modular Manual Actuator Assembly 190-4299-HV0

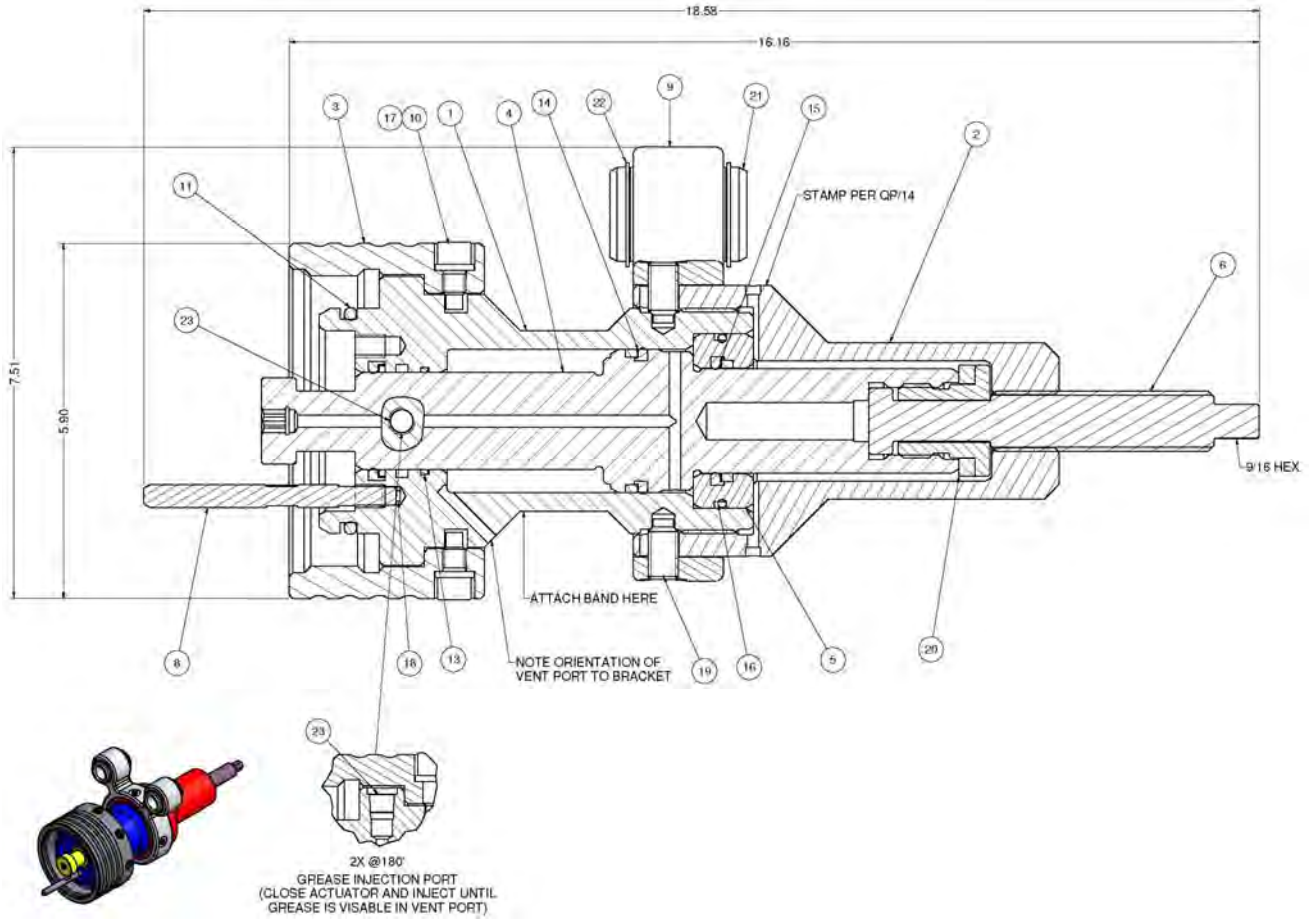


Figure 22: Modular Manual Actuator

Item	Part Number	Quantity	Description
1	190-4277-480	1	3" MOD PISTON HOUSING
2	190-4282-480	1	3" MOD HYDRAULIC CYLINDER HOUSING
3	190-4281-480	1	3" MOD CYLINDER CAP
4	190-4198-480	1	3" MOD ACTUATOR COLLAR
5	190-4278-480	1	3" MOD BALANCED PISTON
6	190-4201-480	1	3" MOD SEAL RING
7	190-4279-480	1	3" MOD HYDRAULIC PISTON
8	190-4286-480	1	3" MOD DRIVE ROD
9	190-4287-480	1	3" MOD DRIVE SLEEVE
10	190-4283-460	1	3" MOD KEY PLATE
11	190-4284-316	1	3" MOD INDICATOR ROD
12	190-4290-480	1	3" RAM GUIDE BAR
13	190-4202-ALU	1	3" MOD BEARING BRACKET
14	190-4319-PEK	1	3" MOD KEY BUSH
15	190-4335-316	8	COLLAR BOLT 3" MOD
16	801-0340-V90	1	O-Ring - B.S Size 340
17	190-3870-H85	1	ROD SEAL
18	190-4343-PEK	1	GREASE SCRAPPER RING
19	802-4340-H85	1	PISTON T-SEAL 2.385
20	802-4339-H85	2	ROD T-SEAL 1.750
21	801-0231-V90	1	O-Ring - B.S Size 231
22	802-4341-H85	1	PISTON T-SEAL 2.750
23	801-0235-V90	1	O-Ring - B.S Size 235
24	802-2505-H85	1	ROD T-SEAL 0.825 DIA
25	802-4342-H85	1	ROD T-SEAL 0.245
26	WNL-0540-316	8	Nord Lock Washer Size 3/8
27	SDU-0585-316	4	Set Screw Dog Point 1/2 UNC X 1.000 in
28	SDU-0505-HTS	3	Set Screw Dog Point Size 1/4 Length 0.75 in
29	SHC-0503-HTS	2	Soc Hd Cap Size 1/4 Length 0.5 in
30	WNL-0500-316	2	1/4" Nordlock Washer
32	WNL-3703-316	1	NORDLOCK WASHER M4
33	100-2209-316	2	NPT SOCKET HEAD PLUG 1/8
34	190-1608-STL	2	Ball Slide (TK-25-UU)
35	190-4338-STL	1	Thrust Bearing (FAG 811 06)
36	190-1756-STL	4	EXTERNAL CIRCLIP (EXT-0400)
37	190-2491-STL	1	EXTERNAL CIRCLIP (SH-75)- 0.750 DIA

Table 12: Modular Hydraulic Actuator Assembly 190-4289-HV0

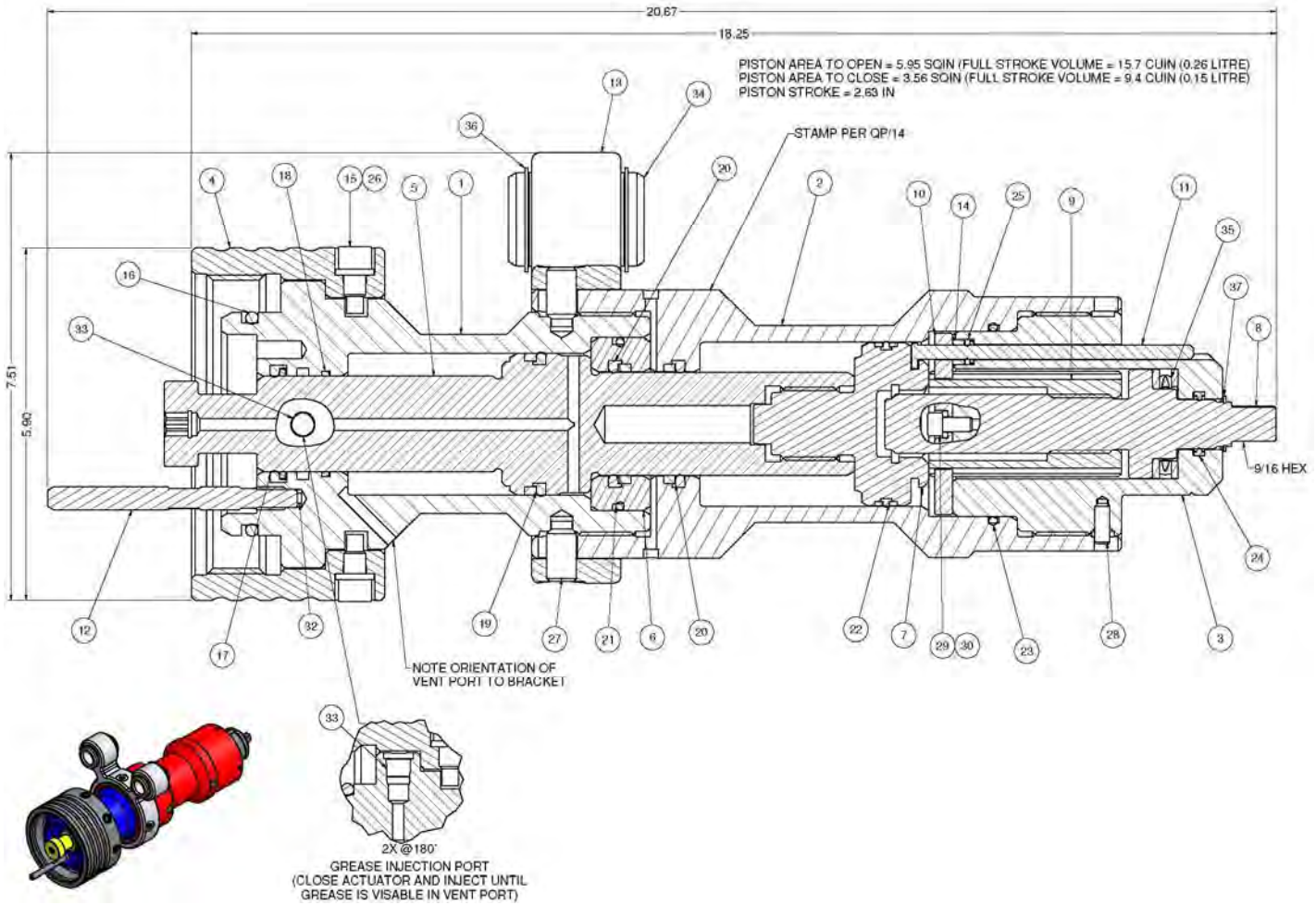

20.67
18.25
PISTON AREA TO OPEN = 5.95 SQIN (FULL STROKE VOLUME = 15.7 CUIN (0.26 LITRE)
PISTON AREA TO CLOSE = 3.56 SQIN (FULL STROKE VOLUME = 9.4 CUIN (0.15 LITRE)
PISTON STROKE = 2.63 IN
STAMP PER QP/14
7.51
5.90
9/16 HEX
NOTE ORIENTATION OF
VENT PORT TO BRACKET
2X @180°
GREASE INJECTION PORT
(CLOSE ACTUATOR AND INJECT UNTIL
GREASE IS VISABLE IN VENT PORT)

Figure 23: 3’’ Modular Actuator Hydraulic

Item	Part Number	Quantity	Description
1	190-4363-480	1	MODULAR NO GUIDE RAM - 3.00"
2	190-4364-480	1	MODULAR GUIDED RAM - 3.00"
3	190-4171-H80	1	3" GUIDING INNER MULTI-SEAL
4	190-4170-H80	1	3" POINTED INNER MULTI-SEAL
5	190-3107-H70	2	BOP OUTER SEAL - 3.50

Table 13: Wireline Ram Assy 190-4360-HH0

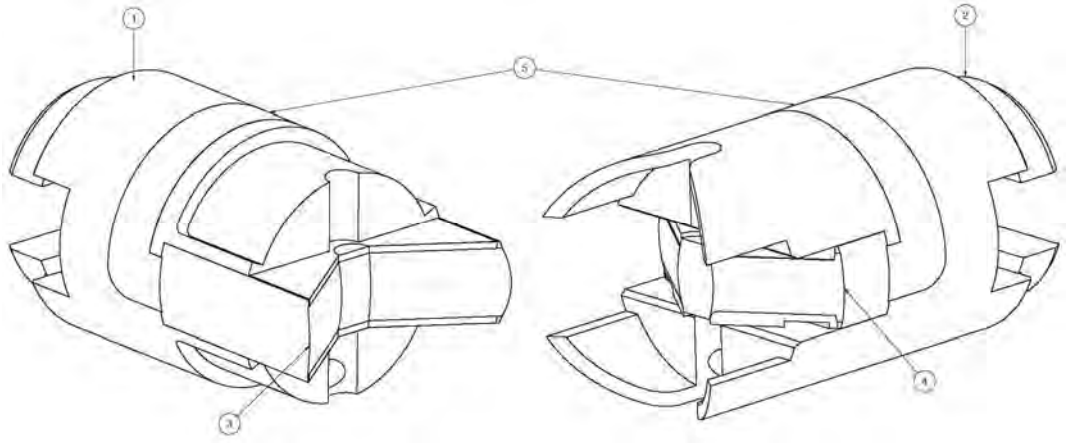


Figure 24: Wireline Ram Assy 190-4360-HH0

Item Number	Part Number	Quantity	Description
1	190-4362-480	1	MODULAR 3" GUIDING SHEAR RAM BODY
2	190-4361-480	1	MODULAR 3" SHEAR RAM BODY (NO FINS)
3	190-4141-H80	1	3" POINTED INNER BLINDSEAL
4	190-4142-H80	1	3" GUIDING INNER BLIND SEAL
5	190-3107-H70	2	BOP OUTER SEAL - 3.50

Table 14: Shear Ram Assy 190-4359-HH0

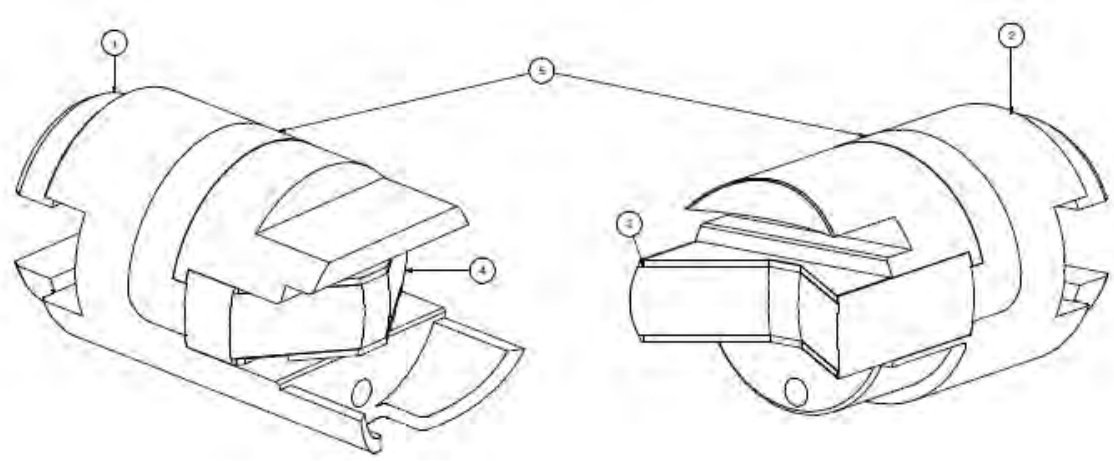


Figure 25: Shear Rams 190-4359-HH0

Item	Part Number	Quantity	Description
1	196-4211-480	1	4-3/4"-4 MODULAR TOP SUB
2	802-4390-H85	1	PISTON T-SEAL 4.300

Table 15: 4-3/4 Top Sub Parts List 196-4324-HV0

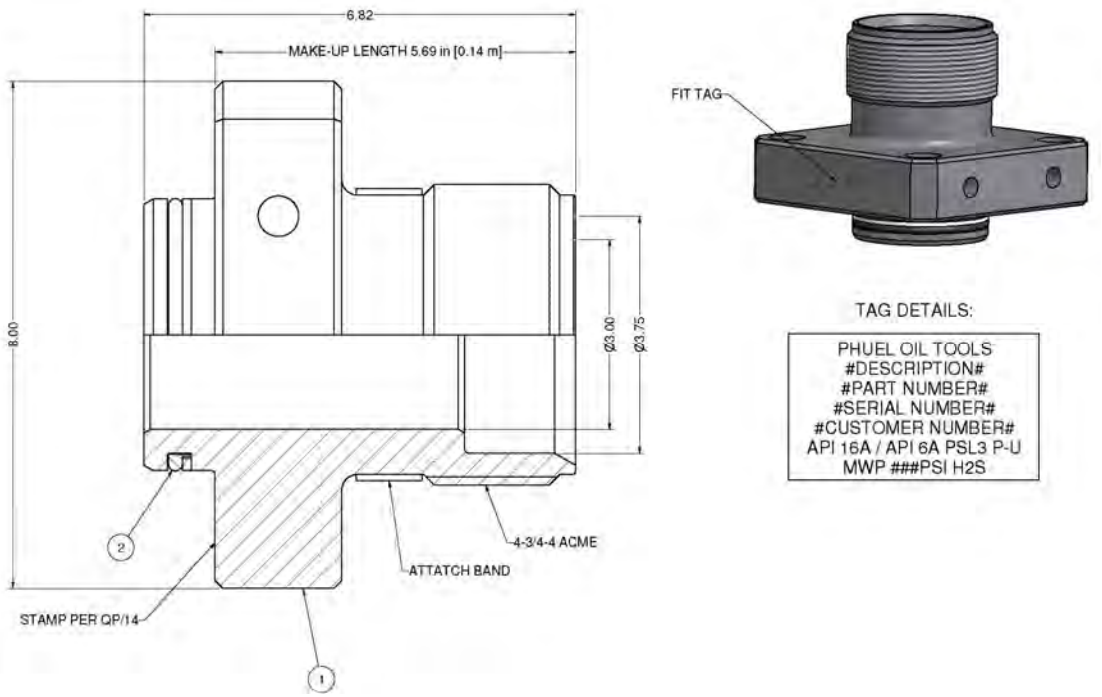


Figure 26: 4 ¾’’-4 QU Top Sub Assy

Item	Part Number	Quantity	Description
1	196-4212-480	1	4-3/4"-4 MODULAR BOTTOM SUB
2	169-4216-480	1	4.75-4 SPLIT COLLAR 10K
3	169-4217-480	1	4.750-4 SPLIT RING 10K
4	SHC-0543-3A4	4	Soc Hd Cap Size 3/8 Length 0.625 in
5	WNL-0540-316	4	Nord Lock Washer Size 3/8
6	801-0340-V90	1	O-Ring - B.S Size 340
99	910-4088-N66	1	4.750-4 ACME MALE THREAD PROTECTOR

Table 16: 4-3/4 Bottom Sub Parts List 196-4325-HV0

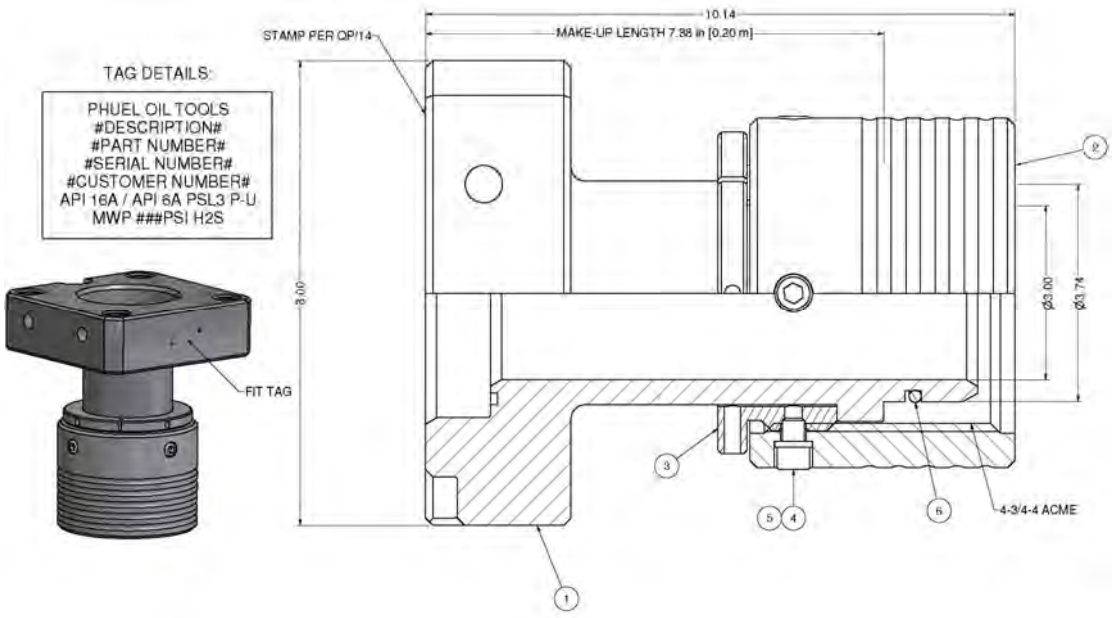


Figure 27: 4 ¾’’-4 QU Bottom Sub Assy

Item	Part Number	Quantity	Description
1	196-4316-480	1	5-3/4"-4 MODULAR TOP SUB
2	802-4390-H85	1	PISTON T-SEAL 4.300

Table 17: 5-3/4 Top Sub Parts List 196-4326-HV0

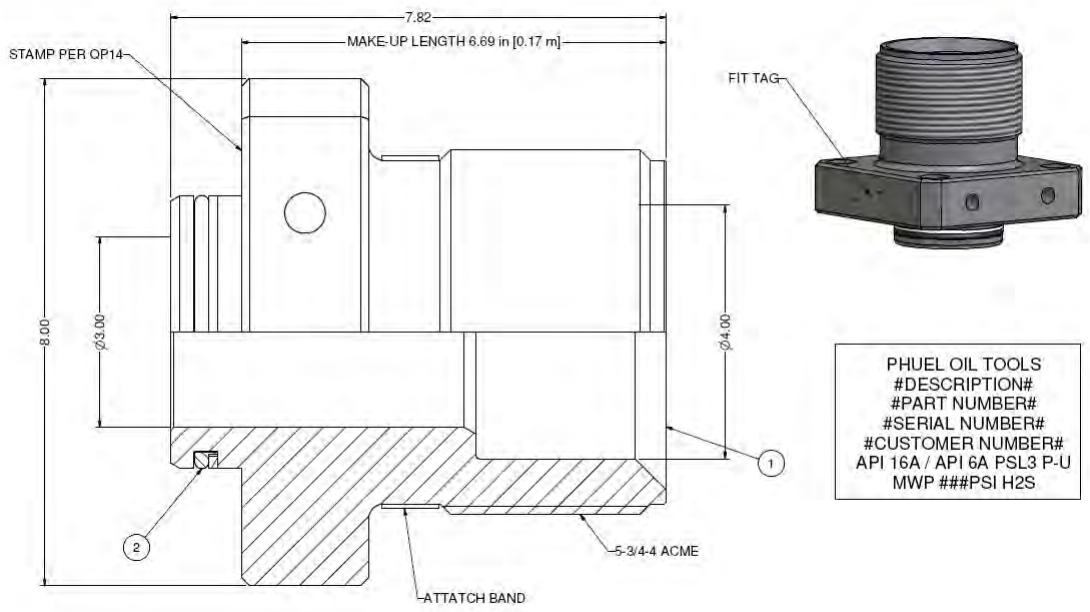


Figure 28: 5 ¾’’-4 QU Top Sub Assy

Item	Part Number	Quantity	Description
1	196-4315-480	1	5-3/4"-4 MODULAR BOTTOM SUB
2	169-1995-480	1	SPLIT COLLAR 5-3/4-4 ACME
3	169-1996-480	1	SPLIT RING 5-3/4 -4 ACME
4	SHC-0543-3A4	4	Soc Hd Cap Size 3/8 Length 0.625 in
5	WNL-0540-316	4	Nord Lock Washer Size 3/8
6	801-0342-V90	1	O-Ring - B.S Size 342 (5.3/4"-4 Ouick Union)

Table 18: 5-3/4 Bottom Sub Parts List 196-4327-HV0

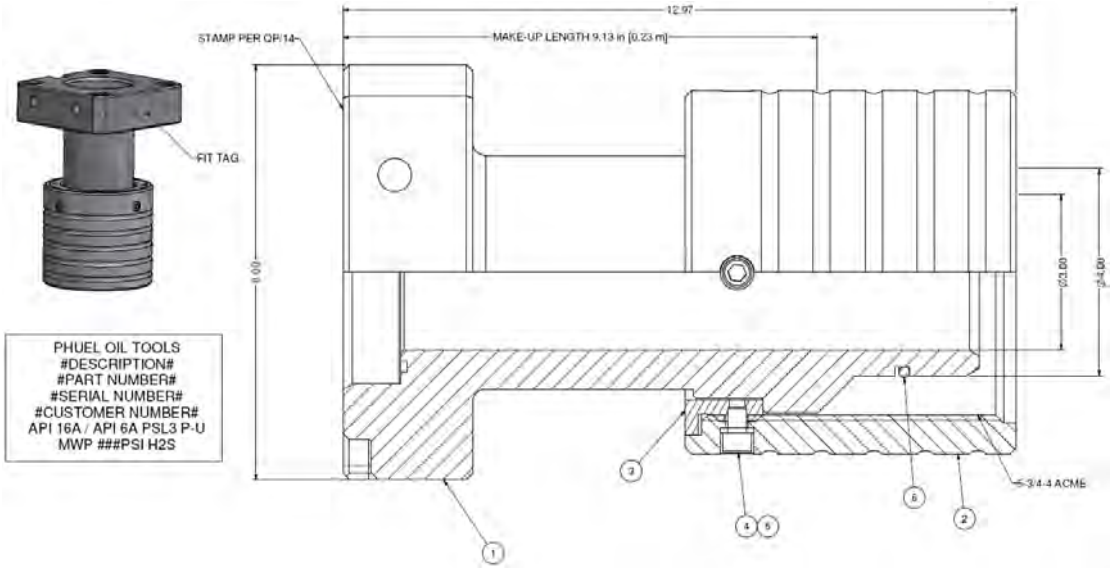


Figure 29: 5 ¾’’-4 QU Bottom Sub Assy

Item	Part Number	Description
1	190-4255-480	MOD EQUALISATION BLOCK
2	190-4285-480	MOD EQUALISING END VALVE SAVERSUB
3	190-4275-480	3" MOD CONNECTING BAR
4	145-2176-480	SAVER SUB PORT
5	205-2105-480	BLANK TEST PORT
6	900-3019-480	CHECK HOUSING
7	110-2979-316	VALVE
8	190-2823-PEK	VALVE SEAT
9	100-2114-PEK	CHECK VALVE SEAL
10	190-2786-PEK	CHECK CONE SEAL
11	145-2185-STL	COMP SPRING
12	190-1749-STL	COMP SPRING
13	190-1703-STL	Hollow Lock Screw 3/4-16
14	801-0119-V90	O-Ring - B.S Size 119
15	801-0108-V90	O-Ring - B.S Size 108
16	801-0110-V90	O-Ring - B.S Size 110
17	SHC-0583-3A4	Soc Hd Cap 1/2 UNC Length 3/4 in
18	SHC-0585-3A4	Soc Hd Cap Size 1/2 Length 1 in
19	WNL-0580-316	WASHER NORDLOCK (M12)
20	SBC-0543-304	Button Hd Screw Size 3/8 Length 0.625 in
21	WNL-0540-316	Nord Lock Washer Size 3/8
22	SHC-0586-3A4	Soc Hd Cap Size 1/2" UNC Length 1.25 in
23	190-2821-316	PORT BLANK END

Quantities depend on the configuration

Table 19: 190-4450-HV0 Parts List

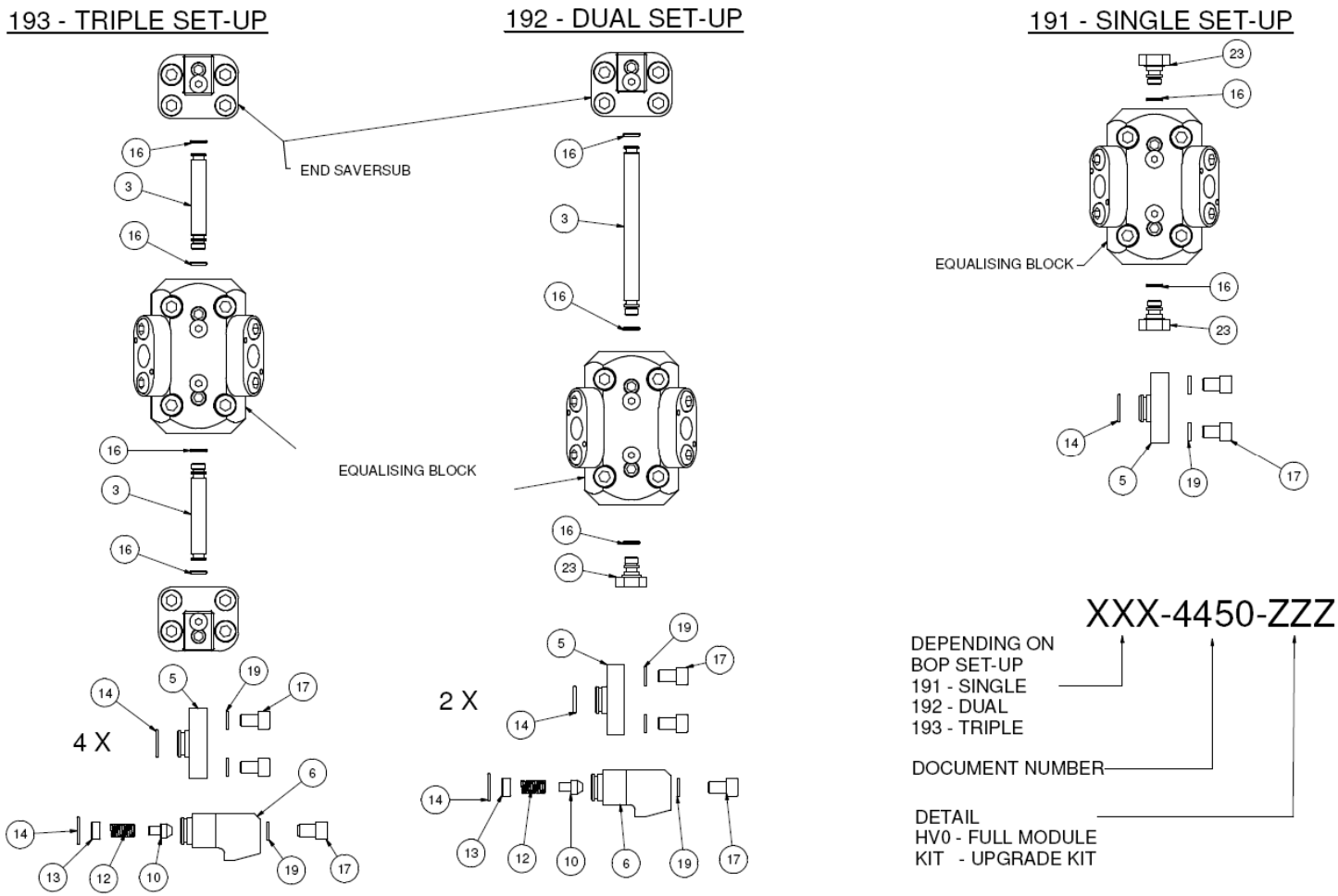


Figure 30: Equalising Block Configurations

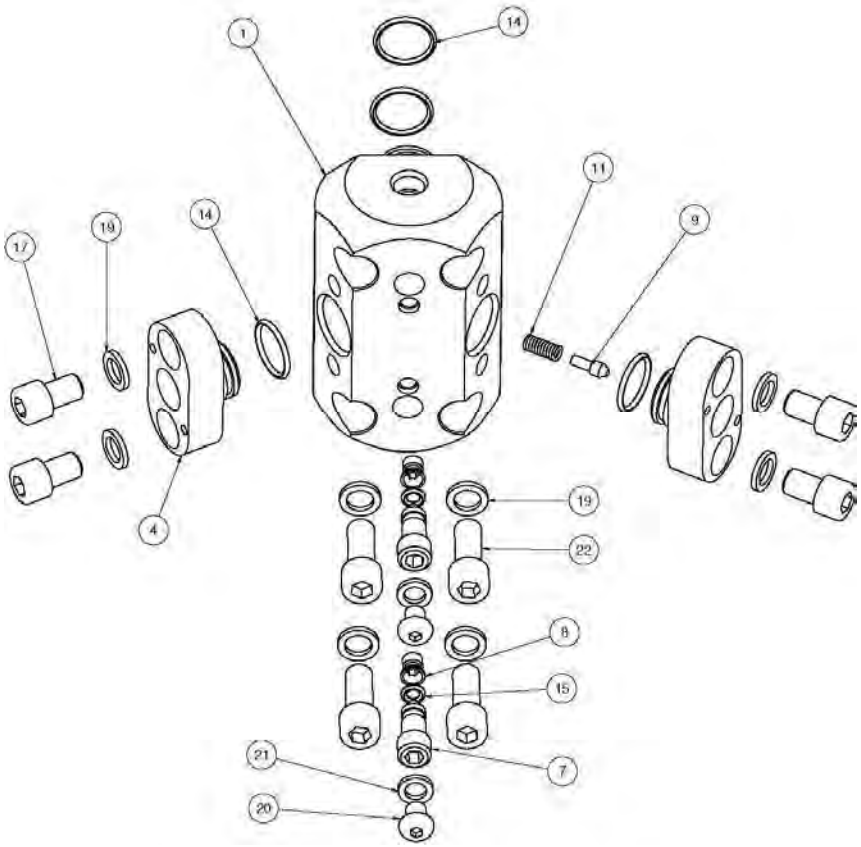


Figure 31: Equalisation Assy 191-4450-HV0

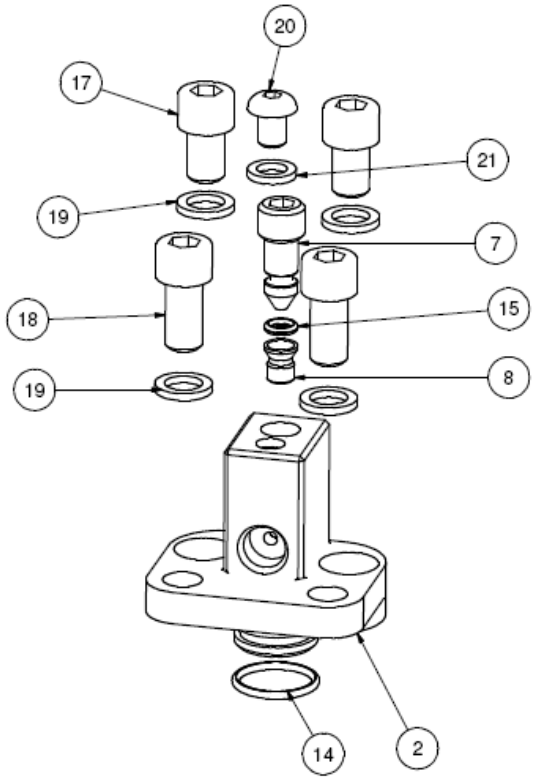


Figure 32: End Saversub Assy 191-4450-HV0

Item Number	Part Number	Quantity	Description
1	191-4288-AL7	4	3" MOD SINGLE BODY TIE BAR
2	195-1964-A2H	4	HEX NUT - 1.125-8 UN

Table 20: Connecting Collar Parts List 196-4188-SS0

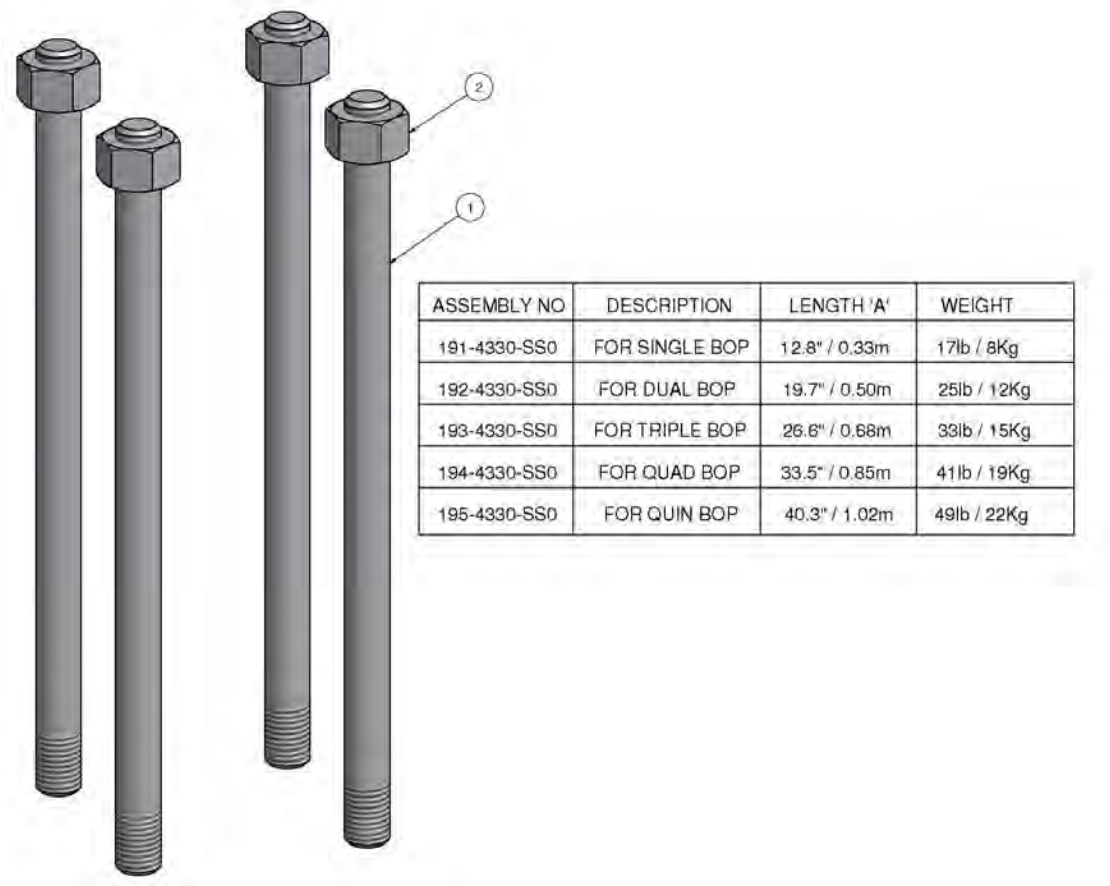


Figure 33: Connecting Collar Assembly 196-4188-HS0

Item	Part Number	Quantity	Description
1	190-2746-STL	2	1/4 SNAPTITE COUPLER (PT.NO. SVHC44FV)
2	950-3717-316	4	3/8’’ NPT x ¼’’ NPT Connector
3	950-4434-316	4	NPT SOCKET HEAD PLUG 1/4

Table 21: Modular BOP Hydraulic Fittings 190-4433-HS0

Item	Part Number	Quantity	Description
1	950-2558-316	2	1/4 SNAPTITE COUPLER (PT.NO. SVHC44FV)
2	950-2559-316	2	1/4 SNAPTITE NIPPLE (PT.NO. SVHN44FV)
3	950-2587-316	4	MALE NIPPLE 1/4in NPT
4	950-4434-316	4	NPT SOCKET HEAD PLUG 1/4

Table 22: Modular BOP Hydraulic Fittings 190-4433-HS1

9 Spares

Use only spares supplied or approved by Phuel Oil Tools Ltd.

It is recommended that sufficient quantities of the following spares be maintained to ensure that the equipment is always available when required.

Elastomeric spares are supplied in Viton material as standard. Other materials are available please specify when ordering.

Part Number	Quantity	Description	Comment
802-4390-H85	1	PISTON T-SEAL 4.300	
RDK-4289-HV0	2	Hydraulic Actuator Redress Kit	

Table 23: BOP Body with Hydraulic Actuator Redress Kit RDK-4328-HV0

Part Number	Quantity	Description	Comment
802-4390-H85	1	PISTON T-SEAL 4.300	
RDK-4299-HV0	2	Manual Actuator Redress Kit	

Table 24: BOP Body with Manual Actuator Redress Kit RDK-4329-HV0

Part Number	Quantity	Description	Comment
190-4319-PEK	1	3" MOD KEY BUSH	
801-0340-V90	1	O-Ring - B.S Size 340	
190-3870-H85	1	ROD SEAL	
190-4343-PEK	1	GREASE SCRAPPER RING	
802-4340-H85	1	PISTON T-SEAL 2.385	
802-4339-H85	2	ROD T-SEAL 1.750	
801-0231-V90	1	O-Ring - B.S Size 231	
802-4341-H85	1	PISTON T-SEAL 2.750	
801-0235-V90	1	O-Ring - B.S Size 235	
802-2505-H85	1	ROD T-SEAL 0.825 DIA	
802-4342-H85	1	ROD T-SEAL 0.245	

Table 25: Hydraulic Actuator Redress Kit RDK-4289-HV0

Part Number	Quantity	Description	Comment
801-0340-V90	1	O-Ring - B.S Size 340	
190-3870-H85	1	ROD SEAL	
190-4343-PEK	1	GREASE SCRAPPER RING	
802-4340-H85	1	PISTON T-SEAL 2.385	
802-4339-H85	1	ROD T-SEAL 1.750	
801-0231-V90	1	O-Ring - B.S Size 231	

Table 26: Manual Actuator Redress Kit RDK-4299-HV0

Part Number	Quantity	Description	Comment
190-4171-H80	1	3" GUIDING INNER MULTI-SEAL	
190-4170-H80	1	3" POINTED INNER MULTI-SEAL	
190-3107-H70	2	BOP OUTER SEAL - 3.50	

Table 27: Wireline Ram Redress Kit RDK-4360-HH0

Part Number	Quantity	Description	Comment
190-4142-H80	1	3" BLIND GUIDING INNER SEAL	
190-4141-H80	1	3" BLIND POINTED INNER SEAL	
190-3107-H70	2	BOP OUTER SEAL - 3.50	

Table 28: Shear Ram Redress Kit RDK-4359-HH0

Part Number	Quantity	Description	Comment
190-2823-PEK	2	VALVE SEAT	
801-0119-V90	5	O-Ring - B.S Size 119	
801-0108-V90	2	O-Ring - B.S Size 108	
801-0110-V90	2	O-Ring - B.S Size 110	

Table 29: Single Injection Module Redress Kit RDK-4450-HV1

Part Number	Quantity	Description	Comment
190-2823-PEK	3	VALVE SEAT	
801-0119-V90	8	O-Ring - B.S Size 119	
801-0108-V90	3	O-Ring - B.S Size 108	
801-0110-V90	3	O-Ring - B.S Size 110	

Table 30: Dual Injection Module Redress Kit RDK-4450-HV2

Part Number	Quantity	Description	Comment
190-2823-PEK	4	VALVE SEAT	
801-0119-V90	11	O-Ring - B.S Size 119	
801-0108-V90	4	O-Ring - B.S Size 108	
801-0110-V90	4	O-Ring - B.S Size 110	

Table 31: Triple Injection Module Redress Kit RDK-4450-HV3

Part Number	Quantity	Description	Comment
802-4390-H85	1	PISTON T-SEAL 4.300	For Top Sub
801-0340-V90	1	O-Ring - B.S Size 340	

Table 32: 4 ¾’’-4 Top and Bottom Sub Redress Kit RDK-4325-HV0

Part Number	Quantity	Description	Comment
802-4390-H85	1	PISTON T-SEAL 4.300	For Top Sub
801-0342-V90	1	O-Ring - B.S Size 342	

Table 33: 5 ¾’’-4 Top and Bottom Sub Redress Kit RDK-4327-HV0

Individual seals and parts may be ordered as required. See the parts list in the previous section for part numbers

9.1 Supporting Equipment

950-4656-316 - Piston Assembly Tool